TECHNOLOGY INTEGRATION IN SPECIAL EDUCATION: TOOLS, TRENDS AND TRANSFORMATIONS

Dr. M. Karuppasamy | Prof. J. Sujathamalini

SHANLAX
#SINCE1990

TECHNOLOGY INTEGRATION IN SPECIAL EDUCATION: TOOLS, TRENDS AND TRANSFORMATIONS

DOI : doi.org/10.34293/shanlax.9789361637322

Dr. M. KARUPPASAMY

Assistant Professor in Special Education & Course Coordinator,
Government Rehabilitation Institute for Intellectual Disabilities (GRIID),
Chandigarh

Prof. J. SUJATHAMALINI

Head, Department of Special Education and Rehabilitation Science,
Alagappa University, Karaikudi,
Tamilnadu

SHANLAX PUBLICATIONS

Title:	Technology Integration in Special Education: Tools, Trends and Transformations
Editor's Name:	Dr. M. Karuppasamy Prof. J. Sujathamalini
Published by:	Shanlax Publications, Vasantha Nagar, Madurai – 625003, Tamil Nadu, India
Publisher's Address:	61, 66 T.P.K. Main Road, Vasantha Nagar, Madurai – 625003, Tamil Nadu, India
Printer's Details:	Shanlax Press, 66 T.P.K. Main Road, Vasantha Nagar, Madurai – 625003, Tamil Nadu, India
Edition Details (I,II,III):	I
ISBN:	978-93-6163-732-2
DOI:	doi.org/10.34293/shanlax.9789361637322
Month & Year:	August, 2025
Copyright @	Dr. M. Karuppasamy Prof. J. Sujathamalini
Pages:	199
Price:	₹ 540.00/-

CONTENTS

ARTIFICIAL INTELLIGENCE IN PERSONALISED LEARNING FOR CHILDREN WITH MULTIPLE DISABILITIES: INNOVATIONS, CHALLENGES AND FUTURE DIRECTIONS

Dr. Rajesh Ramachandran
Rehabilitation Officer (S & P), Department of Medical Science
NIEPMD, Chennai
rajram42004@gmail.com

Prof. J. Sujathamalini
Head, Department of Special Education and Rehabilitation Science
Alagappa University, Karaikudi
sujatha.malini@gmail.com

Abstract

AI is transforming teaching and learning and creating an unprecedented opportunity introducing individualised, inclusive, and accessible learning environments to children with multiple disabilities. In this chapter, the authors discuss how Artificial Intelligence (AI) learning technologies may be used to improve personalised learning in children with multiple disabilities (MD). It also looks at the role AI plays in special education, such as the response of smart systems to the complicated needs of students with cognitive, sensory, and physical disabilities. It further shows available tools, implementation models and practical applications, and underlying obstacles and ethical areas. The chapter provides ideas on emerging applications which are revolutionizing the fields of special and inclusive education. It offers a critical analysis of the lingering issues on data bias, ethical issues, infrastructure issues and need to collaborate across sectors. Putting the UDL principles and culturally responsive strategies into the spotlight, it concludes with a series of lines of action toward equitable and sustainable integration of AI into inclusive education systems within the mainstreams. In this chapter, we promote a rights-based human-centred design of technology that allows children with multiple disabilities (MD) to love, communicate and learn in their own way and to live their lives on their own terms. Adding on national initiatives such as NEP 2020 and the RPwD Act 2016, this roadmap details how AI can result in successful integration within inclusive education systems both in India and worldwide.

Keywords: *Artificial Intelligence, Personalised Learning, Multiple Disabilities, Assistive Technology, Inclusive Education, NEP 2020, RPwD Act, UDL*

Introduction

With the help of Artificial Intelligence (AI), new realities of inclusive education are being re-carved as it empowers highly adaptive, learner-centred settings. In the case of children with multiple disabilities (MD) who may have learning requirements over and beyond the senses, cognitively, as well as communicative, such teaching potential using an AI can have revolutionary properties to individualise teaching, compared to conventional teaching. The AI is a major change that has been realized particularly in special education. Children with several disabilities also deal with complicated issues regarding communication, mobility, cognition, and sensory processing, and consequently, they need learning systems that are very flexible (Al-Azawei et al., 2017). The use of AI can open the field of responsive, data-driven environment based on individual needs, which can provide an improved access and learning results (Luckin et al., 2016).

Multi Modal Delivery Forms

As artificial intelligence improved, their platforms have been able to dynamically map content to various sensory pathways, e.g. to text-to-speech, speech-to-text, visual representations, tactile feedback and gesture recognition systems. This multimodal strategy will support learners who perceive and learn in different sensory and cognitive ways with different ways to engage with content in order to their sensorial and neuro-cognitive preferences. To offer an example, Augmentative and Alternative Communication (AAC) systems are now AI enhanced and use natural language processing to generate contextually appropriate outputs, which is reaffirming expressive communication among people with non-verbal abilities.

Behavioural and Cognitive Profiling

Machine learning algorithms can analyse behavioural data in order to create customised profiles to dissect the various idiosyncrasies of a given learner such as reaction speed, movement patterns, eye gaze and other factors. Such profiles enable educators and education systems in understanding the way a child assimilation of the information, recognizes the stimuli that trigger the child to become disengaged and which instructional methods are efficacious. The current profiling forms the basis of the creation of adaptive courses of learning that follow the growing rates of a learner. Panjwani-Charania and Zhai (2024) explain that such adaptive learning systems employing AI can work both at the levels of augmentation and redefinition in the SAMR-LD model and provide customized interventions, which are no longer limited to stagnant accommodations.

Predictive Analytics of Learning

With AI, predictive education is possible through trend analysis over time of performance data. These predictive models make it possible to detect early stagnations or decreases in learning, thus timely remedial measures can be taken. Contrary to traditional assessments, rarely performed and usually difficult to access by children with multiple disabilities, AI promotes a continuous and integrated assessment where assessment is both formative and adaptive. UNESCO (2021) identifies that AI can deduce real-time decisions in inclusive classrooms that enable educators to make adjustments to the instructions by predicting them rather than basing them on the past efforts assessment.

Objectives

1. Understand how Artificial Intelligence (AI) can help deliver personalised, child-centred education for children with multiple disabilities.

2. Evaluating current AI tools, pedagogical frameworks and support technologies, and its compliance with regard to the international agendas (SDG 4) and National Education Policy (NEP 2020, RPwD Act 2016).
3. Evaluate ethical, infrastructural, pedagogical and cultural issues that have an impact on the incorporation of AI in inclusive education.
4. Develop context-relevant recommendations to make AI adoption equitable, scalable, and sustainable in advising policies on the rights-based recommendations and strategic directions that would educate policymakers, teachers and technology makers.

Personalised Learning through AI

Personalised learning individualises learning in order to suit an individual learner. It considers the aspects like learning styles, cognitive abilities, preferences and background information. Artificial Intelligence (AI) can be important in this personalisation as it can analyse the vast information about learners and draw conclusions to make changes to instruction. Data analytics, machine learning, and natural language processing are some technologies that allow making revisions to curriculum content, pacing, and support strategies in real-time (Holmes et al., 2019).

An example is that the artificial intelligence systems will have the power to identify where a learner has the problem using a specific concept and in response, it will provide the real time help or additional resources that clearly match the needs of that learner. This is particularly beneficial to students with multiple disabilities because with the help of AI, it is possible to deliver multimodal material, which fully respects the individual sensory and cognitive characteristics of all students. Besides, the AI-amplified solutions can include assistive technologies, including speech-to-text transcriptions, screen-reading applications, and gesture interface resolving software, thereby accelerating inclusive and adaptive educational environments.

UDL uses many developmental strategies of engagement, representation, and expression, and the identified strategies allow providing all learners with access to critical engagement opportunities regardless of their conditions or abilities. Artificial Intelligence (AI) augments the delivery of UDL through dynamic alteration of instructional content, patterns, and methods of delivery in line with live learner analytics. As an illustration, AI can help recommend multimedia learning content to visual learners, decode textual content to students with cognitive impairment, or transcribe the speech to persons with focus issues. With the help of AI, teachers can offer personalised learning journeys without disregarding diversity among learners and ignoring the call of inclusivity, which is included in UDL (CAST, 2018).

AI Tools to Address Diverse Needs

Artificial Intelligence provides a diversity of assistive and adaptive devices that aspire to boost the participation of students with different disabilities in the educational process.

Such mechanisms not only revolutionise improving individual accessibility, but they also enable the possibility of customization of pedagogical means and communication procedures that used to be unimaginable in traditional educational settings.

Through Artificial Intelligence systems, educators are provided with detailed breakdowns of learner behaviours, preferences, and performance trends, and therefore instructional planning is made easy based on empirical data. As an example, dynamic adaptation of the content based on the real-time feedback is implemented by designing adaptive learning algorithms by developers, whereas conversational AI agents provide gradual guidance in customised and discreet form. Such characteristics greatly support differentiated instruction to a considerable extent as it is a major inclusive teaching principle.

Speech and TTS Tools: Apps like Google live transcribe and Microsoft immersive reader strengthen the access of learners who may be speech or language challenged. These devices translate any verbal communication into a written communication and the reverse very quickly, and hence encourage continuous direction of conversation and academic participation in the learning environment.

Predictive Analytics Platforms: Using huge volumes of user interaction data, learning platforms such as Squirrel AI and DreamBox detect learning gaps, propose interventions and adapt the teaching material in real-time. These systems enable educators to spot at-risk students earlier and tailor learning routes to each learner.

AAC Integration: AAC devices such as Proloquo2Go, Jabbla Mind Express, Avaz, and Jellow enable learners with little or no verbal communication to communicate either through symbol based, text based, or voice output based expression systems. These AAC tools apply the predictive text and contextual suggestions whenever possible so that communication could be improved effectively (Light & McNaughton, 2014).

Computer Vision and Emotional AI: These AI features analyse the faces, non-verbal cues, and degrees of engagement to identify the emotional state and cognitive fatigue. The use of these AI tools provides educators with constant feedback, which then prompts them to adjust their approach and optimize teaching strategies, thwart frustration, and increase engagement.

AI for Visual and Hearing Impairments: Some AI assistants, such as Seeing AI and Be My Eyes produced by Microsoft use the audio capabilities of the founders (narrating their surroundings, reading, and recognising people). The given AI tool allows having a real-time subtitle according to the captioning and visual information provided to students with the hearing disorders.

Gamified and Voice-Enabled Learning: Learning games and voice assistants (e.g., Alexa, Google Assistant) powered by AI may engage in learning activities, offer repetitive training of some skills that make them more durable, and reward learners timely and increase their motivation by providing timely feedback.

The early detection and screening of developmental disorders are increasingly being done with the use of AI. Other applications such as Cognoa, Autism AI, and Cogniable interrogate behaviour, eye-tracking, and social responsiveness by establishing evidence of an autism spectrum disorder (ASD) or attention-related issues. Such tools empower either the parent or the caregiver to detect early indication of the disorder, which allows appropriate interventions and subsequent access to special education and other rehabilitation services. Not only do these AI tools add both accessibility and engagement, but also offer a more detailed and coherent learning experience that can evolve within the fast paced needs of children with multiple disabilities.

Implementation and Case Examples

Positive trends have also appeared in the case of inclusions in education with the implementation of AI in different contexts, which demonstrates that these technologies can be scalable and are adaptive to learners, who represent diversity. NEP 2020 promotes the usage of Artificial Intelligence in schools, a strong emphasis on data-oriented learning approaches, as well as the use of technology, involved in fulfilling the inequalities and enhancing learning through effective and moderate usage of technology (Kumar, 2025). Such platforms as DIKSHA and PM eVidya have begun introducing AI-powered functionalities, such as regional language adjustment tools and interactive tests, being easily understandable by children with disabilities. This type of initiative is an example of how the policy commitment can drive scaling of inclusive technology.

Research indicates that AI applications in the classroom allow users to offer more real-time translation, speech to writing communication and even knowing how a student is feeling during which the content is delivered depending on the mood or engagement of the student concerned. A collaborative project led by NCERT, the Assistive Technology Lab (in association with IIT Delhi) has been established, and this will also aim at integrating the AI-based solutions into the model of inclusive education in state schools (Kumar, 2025). Special education through AI can change the game. It is not merely an instrument but a conduit to infinity in need-based learning paths and accessibility means, and a facilitator both to the special needs student as well as their instructors. Students requiring specialized consideration can also benefit a lifesaver with services such as Dreambox Learning or computer intelligence that comes with Google Classroom (Combrink, 2024). Artificial Intelligence (AI) tools, can be customized to the needs of individual children and offer them an equal learning opportunity as it deliver a personalized feedback and adaptive content (Dubey, 2024)

AAC Invention Labs Engineering Pvt. Ltd, in collaboration with the Government of Tamil Nadu and Avaz AAC provided improved communication among children with cerebral palsy and multiple disabilities in the 37 districts in the state respectively. In the same light, the Jellow application that is accessible on Android and iOS platforms and as a desktop application is being utilised by several schools and persons with disabilities and multiple disabilities as it is free of charge. Avaz AAC app has also embedded AI in terms of individual word suggestions and predicting the needs of the user, and Jellow -particularly its implementation of the tool of the Jellow Customized Communicator- applying AI to identify icons and images, and calibrate the tool to the prevalence of user skills.

In their research, Ramya and Shanthi (2025) among teachers demonstrated a rather positive attitude to the practicality of AI-enhanced education technology optimization to work with children with multiple disabilities, and a significant part of them gave it the status of extremely effective on several parameters. The intention of these outcomes is to guide policy and practice in an improved integration of AI in inclusive education.

The assistive device is unique about the way it provides persons with visual impairment with a solution using AI. A gadget called Smart Vision, which might be attached to the side of a pair of glasses, is available at the LV Prasad eye Institute (LVPEI). The AI assists them in locating items around, reading the messages of their user, recognising items to evade straying into the path and even face recognition (Bhakiyasri, 2024).

Implementation Challenges

There exist barriers to AI integration in special education and more so into multiple disabilities. Nevertheless, despite both national and international rhetoric about how promising technologies will transform education, there remain multiple systemic and situational obstacles standing in the way of large-scale and equitable adoption of the technologies to a wide variety of education settings.

Digital Divide

The unequal access to resources in the digital world is one of the barriers that was not eliminated. Rural and remote areas where students study are inclined to a lack of permanent internet connection, adequate technologies, or reliable sources of electricity. Such a digital gap affects children with disability the most, who already do not participate in traditional classrooms (UNESCO, 2021). AI-enhanced learning environments succeed more or less depending on stable technological infrastructure, which however, is distributed unevenly.

Data Ethics

The continuing data collection that is required to make many AI systems effective can be a critical source of ethical problems with regards to surveillance, consent and data privacy. The information of disabled children would be especially vulnerable to violation of privacy because of such data abuse. Moreover, the social inequities can also be deepened by using the algorithms that were trained using inaccurate or unrepresentative data (Baird et al., 2020), and contribute to systemic unfairness in decision-making. To correct these issues, there is a need to learn more about the ethical aspect of the AI creation and place an emphasis on inclusiveness in data engagements (Verma et al., 2023) to speak to every voice and have the tech serve the demands of diverse groups in society. The AI claims will have to be based on ethical guidelines towards fairness, accountability and transparency of AI applications within the industry.

Skill Gaps

Implementing Artificial Intelligence in education opens a range of possibilities and problems, especially rehrding the digital literacy of teachers (Ng et al., 2023). Lack of adequate training and the courage to properly utilize AI tools in classrooms limits the opportunities of the technologies and their positive impact especially on under-resourced environments (Al-Zahrani, 2024). On the one hand, the presence of digital tools is not reassuring because without proper preparation and preparation of teachers, the best use of them is not always guaranteed (Gentile et al., 2023). A substantial number of educators, particularly in low-resource settings, do not know how to use AI tools or feel confident using them in their classrooms. Scholars have indicated that even with the provision of access to digital tools, their use is restricted in the case of limited teacher support and preparation (Holmes et al., 2019).

Another important aspect that needs to be touched upon and improved is the digital literacy level of our teachers. They are vital in the effective application of AI in the educational field. To ensure that teachers are ready to use AI feedback in a practice-based subject matter, training programs should be provided to enable the teachers to use practical experience applying AI-enhanced assistive technologies. The educators also need to acquire suitable digital skills so that they can apply and impart AI (Ng et al.,2023).

Cultural Relevance

The AI systems are developed in English-heavy environment, which is radically dissimilar to other environments where they could be applied, making their operation inapt in such societies as India (Prabhakaran et al., 2022). Such nuance evidences the need to acculturate artificial intelligence technologies in a better way to cater to local languages, dialects, and culturally-specific preferences on learning and, thus, embraces inclusivity and contextuality (Ofosu-Asare, 2024). Overreliance on artificial intelligence tools in the learning of languages can be harmful to the development of critical thinking, problem-solving skills by raising language learners (Thảo et al., 2024). In addition, the perception of learners and educators towards these technological tools determines to a large extent the effectiveness of AI-enhanced language (Woo & Choi, 2021). It is, therefore, crucial to understand the issues and cultural complexities that affect the applicability of AI so that equitable and effective AI-based solutions may be developed.

Financial and Institutional Constraints

Use of Artificial Intelligence in the education system, particularly for learners with multiple disabilities has a lot of potential in terms of individual learning experiences and increased accessibility. However, this is only possible in case the stakeholders are successful in addressing the financial and institutional blockades of the scale and long-term utilization of AI-enhanced solutions. He predicted that there was a considerable threat of not having a surviving child with a partner (Roshanaei et al., 2023). The cost of the initial investment required to build one such AI infrastructure, that is, hardware, software licensing, and supplementary tools could be high, placing a serious challenge on most schools and organisations that deal with the population with disabilities, particularly in a scenario of constrained budget. Pilot projects, no matter how successful at the outset, find that piloting meets the constraints of reliable and sustained funding, as well as supportive organisation, without which there is little likelihood of delivering rapid scale-up or long-term sustainability. Recurring costs associated with maintaining the system, updating the software, and supporting it with technical assistance make this scenario even more complicated, as they are essential in order to promote the efficiency and workability of educational technologies based on artificial intelligence (Agarwal & Vij, 2024).

Policy and Practice Directions

In order to make sure that Artificial intelligence is effectively and ethically embedded into inclusive education, policy, policymakers need to begin with real life, classroom situations, and bring frameworks forward on the basis of participatory, human centred design. In order to harness the advantages of Artificial Intelligence (AI) in inclusive education, policy guidelines should change general recommendations to focus on implementation strategies with a more enforcement, funding, and local adaptations-centric approach (Tanveer et al., 2020). Paradigmatic change is required, as a continuous and situational teacher professional development training the capacity of teachers to engage AI tools, yet taking into consideration the reflective practice of teachers as well (Tammets & Ley, 2023). Additionally, it needs to customise the AI tools and it has locally co-designed it with local stakeholders including the educators/ teachers, parents, and disability advocates to customise AI tools to bilingual/ cultural and pedagogical contexts and has provided meaningful participation and ownership. The assessment should be constant and this will include the quantitative and qualitative information provided by the educators and families and utilizing these to improve or to modify towards the synthetical benefits to the learners.

Vision for the Future

Under the Sustainable Development Goals (SDG 4) that is led by UNESCO, there are plans that by 2030 inclusive and equitable education to all and promotion of lifelong learning must be achieved. When incorporated into moral and rights-based frameworks, AI has the potential to accelerate the goal. Future innovations, be it intelligent tutors and brain-computer interfaces have the potential of transforming the way every student learns. Such innovations might not only help to change the approaches of how students perceive knowledge, but might also guarantee that the environment of learning will be attractive to the learners in terms of satisfying the particular needs of each of them.

Conclusion

The opportunity to incorporate Artificial Intelligence in the educational sector has a lot of potentials of reinventing the landscape of learning, especially in children with multiple disabilities, to allow customised and adaptable learning settings (Roshanaei et al., 2023). Business-oriented strategy must refer to AI capable of supporting the worldwide efforts in regards to inclusionary, equitable, and responsive, resilient learning landscape, to overcome both unique obstacles and diversity within the whole gamut of learners (Roshanaei et al., 2023).

To ensure an inclusive, equitable development, educators must be empowered and there should be a process of bridging digital divides coupled with contextualisation of innovations.

The current trend of incorporating Artificial Intelligence (AI) takes the inclusive education to a new level with adaptive, rights-based, and culturally responsive environments beyond the past practices of the assistive approach to the personalised learning of children with multiple disabilities. In a bid to promote accessibility, participation and tailored pathways, this chapter emphasises the opportunity that multimodal content delivery, predictive analytics and behavioural profiling can offer by aligning AI developments with Universal Design for Learning (UDL) principles and policy requirements that include NEP 2020 and the RPwD Act 2016. To guarantee fair adoption, it emphasises curtailing ethical issues, curtailing bias, overcoming digital gaps, and enhancing educator proficiency. To make inclusive education work in the future, AI should be co-designed by teachers, families, and disability advocates, and significant funding should be allocated to infrastructure and training, and tools should be contextually localised with regard to linguistic and cultural diversity. When incorporated into a strong ethical framework, AI can become a driver towards to scalable, sustainable, and impactful learning ecosystems that enable all learners to reach their full potential possible.

Recommendations

For Policymakers

- Formulate national level AI in education guidelines that are based on rights-based, embracive and ethical structures.
- Locally contextualize AI tools by using regional languages and cultural orientations.
- Continued investing in the underserved areas of the AI infrastructure, AI infrastructure maintenance and AI training.

For Educators & Institutions

- Blend assessment models It is possible to use predictive analytics combined with the occurrence of qualitative teacher insights.
- In assistive and adaptive technologies consider implementing continuous professional development through practical training on the topic of AI literacy.
- To protect the data of the student and to resolve the issue of algorithmic bias, implement AI ethics policies at a school level.

For Technology Developers

- AI algorithms include bias detection and transparency features.
- In collaboration with educators, disability expert and families of individuals with disabilities, co-design the tools with the aim of making them relevant to context.
- Selecting low-bandwidth, and offline capable solutions should be the priority in terms of reaching fairly.

References

1. Agarwal, P., & Vij, A. (2024). Assessing the Challenges and Opportunities of Artificial Intelligence in Indian Education. International Journal for Global Academic & Scientific Research, 3(1), 36. https://doi.org/10.55938/ijgasr.v3i1.71
2. Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2017). Universal Design for Learning (UDL): A Content Analysis of Peer-Reviewed Journal Papers from 2012 to 2015. Journal of the Scholarship of Teaching and Learning, 17(3), 52–73.
3. Al-Zahrani, A. M. (2024). Unveiling the shadows: Beyond the hype of AI in education. Heliyon, 10(9). https://doi.org/10.1016/j.heliyon.2024.e30696
4. Baird, A., Schuller, B., & Schuller, B. (2020). Considerations for a More Ethical Approach to Data in AI: On Data Representation and Infrastructure. https://doi.org/10.3389/FDATA.2020.00025
5. Bhakiyasri, M. (2024). AI enable personalised assistive tools to enhance education of disabled persons and its legal fallacies. International Journal for Multidisciplinary Research (IJFMR)
6. CAST (2018). Universal Design for Learning Guidelines version 2.2. Retrieved from https://udlguidelines.cast.org
7. Combrink, N. (2024, May 15). 5 ways AI can benefit special needs students. WonderBaby.org.
8. Dubey, C. K. (2024). Exploring the role of artificial intelligence in inclusive education. In P. K. Kulhade (Ed.), Inclusive pedagogy as an artificial intelligence (p. 287). Global Books Organisation. (PDF) Exploring the Role of Artificial Intelligence in Inclusive Education
9. Gentile, M., Città, G., Perna, S., & Allegra, M. (2023). Do we still need teachers? Navigating the paradigm shift of the teacher's role in the AI era. Frontiers in Education, 8. https://doi.org/10.3389/feduc.2023.1161777
10. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Centre for Curriculum Redesign.
11. Kumar, R. (2025). Bridging the gap: AI and the future of learning in India and beyond. International Journal for Multidisciplinary Research (IJFMR) E-ISSN: 2582-2160
12. Light, J., & McNaughton, D. (2014). Communicative Competence for Individuals who Require Augmentative and Alternative Communication: A New Definition for a New Era of Communication? Augmentative and Alternative Communication, 30(1), 1–18.
13. Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence Unleashed: An Argument for AI in Education. Pearson Education.
14. Ng, D. T. K., Leung, J. K. L., Su, J., Ng, C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first-century skills in the post-pandemic world. Educational Technology Research and Development, 71(1), 137. https://doi.org/10.1007/s11423-023-10203-6

15. Ofosu-Asare, Y. (2024). Cognitive imperialism in artificial intelligence: counteracting bias with indigenous epistemologies. AI & Society. https://doi.org/10.1007/s00146-024-02065-0
16. Prabhakaran, V., Qadri, R., & Hutchinson, B. (2022). Cultural Incongruencies in Artificial Intelligence. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2211.13069
17. Ramya, M., & Shanthi, R. (2025). Teacher perceptions of AI-enhanced educational technology for children with multiple disabilities. Journal of Information Systems Engineering and Management, 10(18s)
18. Roshanaei, M., Olivares, H., & Lopez, R. R. (2023). Harnessing AI to Foster Equity in Education: Opportunities, Challenges, and Emerging Strategies. Journal of Intelligent Learning Systems and Applications, 15(4), 123. https://doi.org/10.4236/jilsa.2023.154009
19. Thảo, L. T., Hieu, H. H., & Thuy, P. T. (2024). Exploring the Impacts of Chatgpt In efl writing: Student perceptions of Opportunities and Challenges in Vietnamese Higher Education. Kognisi Jurnal Ilmu Keguruan, 1(2), 107. https://doi.org/10.59698/kognisi.v1i2.175
20. UNESCO (2021). Digital Learning and the Teaching Profession: A Global Overview of Digital Education and Policy. Paris: UNESCO Publishing.
21. Verma, K., Milosevic, T., Davis, B., & Norman, J. O. (2023). Designing ethical artificial intelligence (AI) systems with meaningful youth participation: implications and considerations. https://doi.org/10.5210/spir.v2023i0.13512
22. Woo, J. H., & Choi, H. (2021). Systematic Review for AI-based Language Learning Tools. Journal of Digital Contents Society, 22(11), 1783. https://doi.org/10.9728/dcs.2021.22.11.1783
23. Tanveer, M., Hassan, S., & Bhaumik, A. (2020). Academic Policy Regarding Sustainability and Artificial Intelligence (AI). Sustainability, 12(22), 9435. https://doi.org/10.3390/su12229435
24. Tammets, K., & Ley, T. (2023). Integrating AI tools in teacher professional learning: a conceptual model and illustrative case. Frontiers in Artificial Intelligence, 6. https://doi.org/10.3389/frai.2023.1255089

TOOLS FOR SENSORY AND PHYSICAL IMPAIRMENTS

Shahnaz Khan
Assistant Professor
Government Rehabilitation Institute for Intellectual Disabilities (GRIID), Chandigarh

Abstract

Assistive technologies for individuals with sensory and physical impairments have revolutionized accessibility, independence, and participation in education, employment, and daily life. These tools – ranging from screen readers and Braille displays for visual impairments, to hearing aids and cochlear implants for auditory challenges, and mobility aids or prosthetics for physical disabilities – are essential enablers of inclusion. Recent advancements in artificial intelligence, robotics, smart devices, and 3D printing have improved usability, affordability, and customization, though challenges such as cost, awareness, and equitable access remain. This paper reviews current and emerging technologies, analyzes implementation challenges, and discusses implications for academia, practitioners, and policymakers. It aims to provide a comprehensive foundation for understanding how these technologies shape a more inclusive future.

Tools and technologies designed for individuals with sensory and physical impairments have significantly transformed the way people with disabilities live, learn, and work. These tools, often called assistive devices or assistive technologies, are created to help overcome challenges related to vision, hearing, movement, and other physical functions. The main goal of these tools is to provide independence, improve communication, enhance mobility, and ensure full participation in society.

*For individuals with **sensory impairments**, such as blindness or low vision, common tools include screen readers, magnifiers, Braille displays, audio books, and tactile maps. These devices help users access printed or digital content through audio or touch. For those with **hearing impairments**, technologies like hearing aids, cochlear implants, speech-to-text converters, vibrating alert systems, and sign language interpreters make communication easier and more effective.*

*People with **physical impairments** – such as those who have difficulty walking, holding objects, or performing daily tasks – benefit from mobility aids like wheelchairs, walkers, and prosthetic limbs. Other tools include adaptive switches, speech recognition software, ergonomic keyboards, and eye-tracking systems, which allow individuals to control computers and other devices using their voice or eye movements.*

Recent advancements in artificial intelligence, robotics, and smart technology have made many of these tools more powerful and easier to use. For example, smart wheelchairs with sensors can help users avoid obstacles, and AI-powered apps can describe surroundings to visually impaired users in real time.

*Overall, these tools are essential for promoting **inclusion, independence, and equal opportunities** for people with sensory and physical impairments. They help break down barriers in education, employment, transportation, and communication, making society more accessible and inclusive for everyone.*

Keywords: *Assistive technology, sensory impairment tools, physical impairment aids, accessibility innovations, inclusive design, adaptive devices, visual impairment technology, hearing loss solutions, mobility aids, prosthetics, Braille technology, AI in accessibility, rehabilitation technology, universal design, disability inclusion.*

Introduction

Disabilities, whether congenital or acquired, affect an individual's ability to perform routine tasks. Sensory impairments include vision and hearing difficulties, while physical impairments relate to movement and coordination challenges. Modern technology has made it possible for people with such disabilities to overcome barriers in communication, mobility, and education through assistive tools. These tools not only enhance independence but also promote equality and participation in society.

Objectives

This paper aims to:

1. Examine a range of assistive technologies for individuals with sensory and physical impairments.
2. Compare traditional and emerging tools in terms of functionality, accessibility, and cost.
3. Identify key challenges in implementation and adoption.
4. Provide evidence-based recommendations for enhancing accessibility.
5. Explore the academic, practical, and policy implications of integrating assistive technologies into society.
6. Offer a synthesized critical analysis of existing literature and identify future research directions.

Understanding Sensory Impairments and Available Tools:

Visual Impairments

Individuals with visual impairments, such as blindness or low vision, benefit from:

- **Screen readers**: These convert text into speech or Braille.
- **Braille technology**: Braille notetakers and refreshable Braille displays help users access digital content.
- **Magnification software and devices**: These enlarge text/images on screens and printed materials.
- **Navigation tools**: GPS-based devices assist visually impaired users in moving around safely.

Hearing Impairments

People with hearing loss use a range of tools to enhance communication:

- **Hearing aids**: Amplify sounds and improve hearing in various environments.
- **Cochlear implants**: Provide direct stimulation to the auditory nerve.
- **Captioning and transcription services**: Convert speech into written text in real time.
- **Visual alert systems**: Replace sound-based alerts with visual or vibrating notifications.

Tools for Physical Impairments

Physical impairments impact mobility and motor control. The following tools help improve daily function:

- **Mobility aids**: Wheelchairs (manual and powered), walkers, and scooters.
- **Prosthetics**: Artificial limbs that restore function and appearance.
- **Environmental control systems**: Allow control of lights, appliances, and doors through switches or voice commands.

- **Modified input devices**: Special keyboards, mice, or joysticks designed for limited dexterity.
- **Wearable exoskeletons**: Robotic suits that assist with walking and movement rehabilitation.

Emerging Technologies and Innovations

The rapid growth of technology has brought innovation to assistive tools:

- **Artificial Intelligence (AI)**: AI-based apps offer real-time object or scene descriptions for the visually impaired.
- **Augmented and Virtual Reality (AR/VR)**: Used in therapy and education for both sensory and motor impairments.
- **Smart homes**: Devices with voice control and automation improve home accessibility.
- **3D printing**: Enables affordable, customized prosthetic limbs and Braille learning tools.

Challenges in Implementation

Despite technological progress, several challenges persist:

- **Cost and affordability**: High-end assistive devices can be expensive.
- **Lack of awareness**: Many users and caregivers are unaware of available tools.
- **Limited access in rural areas**: Urban centers tend to have better support systems.
- **Training and support**: Users need adequate training to operate complex tools effectively.

Implications

- Academic Implications: This research expands the theoretical understanding of assistive technology adoption, providing a comparative framework for future studies in rehabilitation engineering, inclusive education, and human-computer interaction.
- Practical Implications: For practitioners, the findings highlight the importance of personalized technology selection, adequate user training, and integration into existing support systems to maximize impact.
- Policy Implications: Policymakers can leverage these insights to formulate guidelines that ensure affordability, infrastructure development, and equitable distribution of assistive tools, especially in underserved areas.

Conclusion

Assistive tools for sensory and physical impairments are powerful enablers of inclusion, equality, and independence. As technology continues to evolve, it is essential to ensure that these advancements are affordable, accessible, and user-friendly. Through collective efforts in innovation, awareness, and policy-making, a more inclusive world can be built for people of all abilities.

References

1. Alper, M., & Goggin, G. (2017). Digital technology and rights in the lives of people with disabilities. New Media & Society, 19(5), 726–740. https://doi.org/10.1177/1461444816686323
2. Cook, A. M., & Polgar, J. M. (2020). Assistive Technologies: Principles and Practice (5th ed.). Elsevier.
3. Lancioni, G. E., et al. (2020). Technology-aided programs for supporting communication and leisure in people with significant disabilities. Frontiers in Public Health, 8, 81.
4. Shinohara, K., & Wobbrock, J. O. (2016). Self-conscious or self-confident? A diary study of people with visual impairments interacting with technology. ACM Transactions on Accessible Computing, 8(1), 1–31.
5. Goggin, G., & Ellis, K. (2018). Disability and the media. Palgrave Macmillan. Borg, J., & Larsson, S. (2021). Assistive technology use is associated with reduced service needs among people with disabilities. Disability and Rehabilitation: Assistive Technology, 16(5), 492–500.
6. Hersh, M., & Johnson, M. A. (2019). Assistive Technology for Visually Impaired and Blind People. Springer.
7. Pape, T. L.-B., et al. (2015). Technology and participation in society for people with disabilities. Rehabilitation Research, Policy, and Education, 29(4), 273–281.
8. Phillips, B., & Zhao, H. (1993). Predictors of assistive technology abandonment. Assistive Technology, 5(1), 36–45.
9. Wehmeyer, M. L. (2019). Technology and the Promise of Universal Design for Learning: Achieving Equity and Inclusion. Harvard Education Press.
10. American Foundation for the Blind. (2022). *Assistive technology guide*. https://www.afb.org
11. Murchland, S., & Parkyn, H. (2019). *Assistive technology for children with disabilities*. UNICEF.https://www.unicef.org/reports/assistive-technology-children-disabilities
12. National Institute on Deafness and Other Communication Disorders. (2023). *Assistive devices for people with hearing, voice, speech, or language disorders*. https://www.nidcd.nih.gov
13. United Nations. (2021). *Disability and development report: Realizing the sustainable development goals by, for and with persons with disabilities*. https://www.un.org/development/desa/disabilities/publication-disability-sdg.html
14. World Health Organization. (2022). *Global report on assistive technology*. https://www.who.int/publications/i/item/9789240062887

THE ROLE OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Dr.B.Rasina Begum
Assistant Professor (Senior Grade), Department of Computer Science and Engineering (Data Science), Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Chennai

Abstract

Artificial Intelligence (AI) is revolutionizing the educational sector by enhancing teaching methods, personalizing learning experiences, and streamlining administrative processes. With the integration of technologies such as Virtual Reality (VR), Augmented Reality (AR), chatbots, expert systems, and intelligent tutoring systems, AI offers interactive, adaptive, and immersive educational solutions. Its applications include providing tailored feedback, predicting student performance, and creating engaging virtual environments. While AI holds immense potential to improve accessibility, efficiency, and engagement, it also presents challenges such as data privacy, equity issues, and the risk of over-reliance on technology. This paper examines the evolution, applications, benefits, and ethical considerations of AI in education, emphasizing the importance of responsible integration to ensure human-centered learning.

Keywords: *Virtual Reality (VR), Augmented Reality (AR), Chatbots, Expert Systems, Machine Learning, Personalized Learning*

Introduction

Artificial Intelligence (AI) is dramatically transforming the educational landscape. Traditionally, learning relied on instructor-led, mechanical methods, but with the advent of personal computers, educational practices have steadily progressed. The infusion of AI has further quickened this evolution by introducing advanced tools like Augmented Reality (AR), Virtual Reality (VR), intelligent tutoring systems, and chatbots that enrich the learning experience. Additionally, the COVID-19 pandemic accelerated the shift toward online and fully virtual educational models supported by AI technologies.

This chapter explores how AI is transforming educational systems, its key applications, potential benefits, and the challenges and ethical issues that accompany its implementation.

Objectives

- To explore the evolution of AI in the educational domain.
- To analyze the key applications of AI, including chatbots, expert systems, and intelligent tutoring systems.
- To evaluate the benefits of AI in enhancing personalization, accessibility, efficiency, and engagement.
- To discuss challenges and ethical considerations in AI-driven education.
- To propose recommendations for responsible and equitable AI integration in educational systems.

Evolution of AI in Education

Prior to the introduction of computers, education was solely dependent on human instructors and conventional teaching practices. The emergence of microcomputers and personal computers during the 1970s democratized access to technology, making it available in classrooms and transforming instructional approaches. Over time, advances in networking, the Internet, and software development have further broadened the scope of technology-supported learning and computer-assisted education. Artificial Intelligence has capitalized on these technological improvements by enabling machines to adapt, address complex tasks, and simulate human-like reasoning. Experts define AI as systems that can carry out functions traditionally requiring human cognition, including speech recognition, decision-making, and problem-solving. Today, with the integration of sensors and smart devices, AI extends beyond standard computers to include smartphones, tablets, and robotic systems.

Applications of AI in Education

1. Chatbots

AI-powered chatbots assist students by responding to routine queries, providing timely feedback, and helping them navigate coursework. While some studies report inconsistent results regarding their long-term influence on student motivation, chatbots continue to be useful for managing repetitive tasks and administrative functions.

2. Expert Systems

Expert systems apply artificial intelligence to deliver adaptive, data-informed support to educators and learners. For instance, learning management systems (LMS) may utilize expert systems to suggest educational resources, customize lesson plans, and track learner progress. Research indicates that expert systems enhanced with AI capabilities can positively influence educational outcomes, especially within blended learning frameworks.

3. Intelligent Tutoring Systems

Intelligent tutoring systems harness AI to deliver customized instruction and real-time feedback to students. These tools adjust to individual learner needs, offer prompts that encourage reflective thinking, and foster the development of problem-solving abilities. Studies have shown that such intelligent agents can enhance student engagement and promote more profound learning experiences.

4. Machine Learning

Machine learning techniques empower educational technologies to detect patterns, anticipate student performance, and modify instructional materials accordingly. For example, algorithms based on machine learning have been utilized to forecast students' attitudes toward cloud-based educational platforms and adjust pedagogical approaches to better suit their preferences.

5. Personalized Learning Systems

AI supports the creation of deeply personalized learning environments that align educational resources and activities with each student's unique requirements. Research has demonstrated that such systems can boost engagement and improve learning outcomes in fields like programming, mathematics, and language acquisition. Popular learning platforms, including Udemy and Byju's, have effectively incorporated AI to deliver a tailored learning experience.

6. Virtual and Augmented Reality

The integration of AI with virtual and augmented reality technologies enables the creation of immersive educational experiences that elevate student engagement and motivation. Virtual learning spaces foster collaboration, promote visualization of intricate ideas, and provide realistic interactive scenarios. Augmented reality, in particular, allows younger learners to experience educational content in engaging and memorable ways—for instance, viewing 3D dinosaurs while studying prehistoric topics.

Benefits of AI in Education

Personalization: Enables the customization of learning pathways according to each learner's abilities and progress.

Accessibility: Assists a wide range of students, including those with disabilities, by providing supportive tools and resources.

Efficiency: Streamlines administrative processes, allowing educators to dedicate more time to instruction.

Engagement: Enhances student motivation through interactive and game-based learning experiences.

Challenges and Ethical Considerations

Although AI offers numerous advantages, it also poses important challenges:

- **Data Privacy:** Because AI systems process large volumes of personal data, safeguarding privacy and ensuring data security are critical concerns.
- **Equity:** Advanced AI solutions may only be affordable to well-funded educational institutions, potentially increasing disparities among schools and students.
- **Dependence on Technology:** Excessive reliance on AI might diminish human interaction and weaken learners' critical thinking skills.
- **Job Displacement:** There is apprehension among educators, counselors, and administrative staff that AI systems could replace their roles.
- **Ethical Use:** AI-driven decisions may inherit or amplify biases if the systems are not carefully designed and continuously monitored.

Future Directions

Artificial Intelligence is a continuously advancing field, and its influence on education is expected to expand further. It is essential for policymakers, educators, and researchers to work together in establishing ethical frameworks and best practices to ensure that AI acts as a supportive tool rather than a replacement for educators. Ultimately, the greatest value of AI in education lies in enhancing the teaching process, enriching learning environments, and equipping students for a world increasingly driven by technology.

Conclusion

Artificial Intelligence offers significant potential to reshape educational practices. With applications ranging from chatbots to virtual reality, AI can foster personalized learning, boost engagement, and broaden educational opportunities. Nevertheless, its adoption must be managed responsibly to prevent ethical concerns and to maintain the human-centered nature of education. The successful future of AI in educational contexts will rely on careful integration, ongoing research, and a dedication to empowering both educators and students.

References

1. Seldon, A., & Abidoye, O. (2018). *The Fourth Education Revolution*. University of Buckingham Press.
2. Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A. (2018). Artificial intelligence trends in education: A narrative overview. *Procedia Computer Science, 136*, 16-24.
3. Dai, C. S., Chai, C. S., Lin, P. Y., et al. (2020). Promoting students' well-being by developing their readiness for the artificial intelligence age. *Sustainability, 12*(16).
4. UNESCO (2019). How Can Artificial Intelligence Enhance Education? Retrieved from https://en.unesco.org/news/how-can-artificial-intelligence-enhance-education
5. Knox, J. (2020). Artificial intelligence and education in China. Learning, Media and Technology, 45(3).
6. Pokrivcakova, S. (2019). Preparing teachers for AI-powered technologies in language education. Journal of Language and Cultural Education, 7(3), 135-153.
7. Murphy, F. (2019). Artificial intelligence applications to support K-12 teaching. Educational Technology Research.
8. Belpaeme, T., Kennedy, J., Ramachandran, A., et al. (2018). Social robots for education: A review. Science Robotics, 3(21).
9. Murphy, F. (2019). Artificial intelligence applications to support K-12 teaching. Educational Technology Research.
10. Belpaeme, T., Kennedy, J., Ramachandran, A., et al. (2018). Social robots for education: A review. Science Robotics, 3(21).

HARNESSING EMERGING TECHNOLOGIES: VR, AR AND AI FOR INCLUSIVE AND PERSONALIZED LEARNING IN SPECIAL EDUCATION

P. Arun Kumar, M.Tech., MBA
Assistant Professor, Department of Artificial Intelligence & Machine Learning,
HKBK College of Engineering, Affiliated to VTU Belgaum,
Nagawara, Bangalore, Karnataka, India
aimlarun2024@gmail.com

Dr. R. Sivakumar, Ph.D
Associate Professor, Department of Information Science and Engineering,
Don Bosco Institute of Technology (Autonomous)
Affiliated to VTU Belgaum, Kumbalagodu, Bangalore, Karnataka, India
drsiva1978@gmail.com

Abstract

Virtual Reality (VR), Augmented Reality (AR), and Artificial Intelligence (AI) are revolutionising the field of special education by providing innovative solutions to support students with diverse needs. These technologies offer immersive, interactive, and personalised learning experiences that can enhance engagement, accessibility, and academic achievement. By leveraging VR/AR and AI, educators can create tailored learning environments that cater to individual students' requirements, promoting inclusivity and equal access to education. This integration of technology has the potential to transform the way students with disabilities learn, interact, and succeed in educational settings.

Keywords: *Assistive Technology Personalised Learning, Virtual Reality (VR), Artificial Intelligence (AI), Special Education, Educational Technology.*

Introduction

The education sector has witnessed a paradigm shift with the integration of technology, transforming the way students learn and interact with educational content. However, students with special needs have often been left behind, facing unique challenges in accessing quality education that caters to their individual requirements. Traditional teaching methods can be limiting, failing to account for the diverse learning styles, abilities, and needs of students with disabilities. The consequences of this can be far-reaching, leading to decreased academic achievement, lower self-esteem, and reduced opportunities for social and economic participation.

Background

The integration of technology in special education has been shown to have a positive impact on student outcomes, including increased engagement, motivation, and academic achievement.

Objectives

This paper aims to explore the potential applications, benefits, and challenges of Virtual Reality (VR), Augmented Reality (AR), and Artificial Intelligence (AI) in special education. The specific objectives of this study are:

1. **To examine the current state of VR/AR and AI integration in special education**, highlighting successful implementations and potential areas for growth.
2. **To identify the benefits and challenges** of using VR/AR and AI in special education, including their impact on student outcomes, engagement, and accessibility.
3. **To discuss the potential applications** of VR/AR and AI in special education, including social skills development, life skills training, academic learning, and therapy and intervention.
4. **To inform the development of effective strategies** for implementing and integrating VR/AR and AI technologies in special education, promoting inclusive and personalized learning environments.

Virtual Reality (VR) in Special Education

Virtual Reality (VR) offers immersive, interactive experiences that mimic real-world environments, providing a unique opportunity for students with diverse needs to learn and grow.

Immersive Learning Experiences:

VR can create interactive, engaging learning environments that cater to diverse learning styles.

Examples include:

- Virtual labs for science experiments
- Interactive 3D models for anatomy or history lessons
- Virtual field trips to historical sites or museums
- Immersive language learning experiences

Social Skills Development

VR simulates social scenarios, helping students with autism or other social challenges practice social interactions.

Examples Include

- Practising job interviews or conversations
- Role-playing social situations, such as sharing or taking turns
- Interacting with virtual peers or mentors
- Developing empathy through perspective-taking experiences

Accessibility

VR provides equal access to learning experiences for students with physical disabilities. Examples include:

- Virtual wheelchair-accessible environments for students with mobility impairments
- Virtual labs or workshops for students with physical limitations
- Access to virtual field trips or experiences that may be difficult or impossible to access in person
- Personalised accommodations, such as adjustable font sizes or audio descriptions, in VR environments

Augmented Reality (AR) in Special Education

Interactive Learning Materials

AR enhances traditional textbooks by adding interactive elements, such as:

- 3D models and animations
- Videos and audio clips
- Quizzes and games
- Virtual labs and simulations

The above elements when used makes learning more engaging, interactive, and fun, increasing student motivation and participation. AR-enabled textbooks can be accessed through smartphones or tablets, making it easy to integrate technology into the classroom.

Visual Supports

AR provides visual supports for students with learning disabilities, such as:

- Dyslexia: AR can offer text-to-speech functionality, reading aloud text and helping students with reading difficulties.
- Visual processing disorders: AR can provide visual aids, such as highlighting important information or providing graphic organisers.
- Multisensory learning: AR can engage multiple senses, such as sight, sound, and touch, to help students with different learning styles.

Life Skills Training

AR simulates real-life scenarios, helping students practice life skills, such as:

- Shopping: AR can simulate a virtual store, allowing students to practice shopping skills, such as making change or comparing prices.
- Cooking: AR can provide step-by-step cooking instructions, helping students learn meal preparation skills.
- Time management: AR can simulate a virtual clock, helping students practice time-telling and scheduling skills.

Artificial Intelligence (AI) in Special Education

Personalised Learning

AI-powered adaptive learning systems tailor instruction to individual students' needs, abilities, and learning styles.

- Adaptive assessments to identify knowledge gaps
- Customised learning paths and content
- Real-time feedback and adjustment of instruction

Assistive Tools

AI-powered tools assist students with disabilities, such as:

- Speech-to-text software for writing and communication
- Text-to-speech software for reading and comprehension
- Image recognition and description for visual impairments

Predictive Analytics

AI helps identify areas where students may need additional support, enabling early intervention through:

- Analysing student performance data
- Identifying patterns and trends
- Providing insights for targeted support and intervention

Benefits of VR/AR and AI in Special Education:

1. **Increased Accessibility**: VR/AR and AI provide equal access to learning experiences for students with diverse needs.
2. **Improved Engagement**: Interactive and immersive learning experiences increase student engagement and motivation.
3. **Personalised Support**: AI-powered tools offer tailored support, helping students overcome challenges.
4. **Enhanced Learning Outcomes**: VR/AR and AI lead to better understanding, retention, and application of knowledge.
5. **Develops Life Skills**: VR/AR simulations teach life skills, such as social interactions, shopping, and cooking.
6. **Increased Independence**: AI-powered tools and VR/AR experiences promote independence and self-reliance.
7. **Real-time Feedback**: AI provides instant feedback, enabling students to track progress and adjust learning strategies.
8. **Data-Driven Insights**: AI analyses student performance data, providing valuable insights for educators.
9. **Reduced Anxiety**: VR/AR simulations offer a safe and controlled environment, reducing anxiety and stress.
10. **Increased Confidence**: Personalised support and interactive learning experiences boost student confidence and self-esteem.

Implementation Considerations for VR/AR and AI in Special Education

Teacher Training

Educators require training to effectively integrate VR/ AR and AI technologies into their teaching practices.

- Understanding the technology and its applications
- Learning how to use VR/ AR and AI tools in the classroom
- Developing strategies to support students with diverse needs

Accessibility and Equity

Ensure that VR/ AR and AI technologies are accessible to all students, regardless of:

- Abilities: Provide accommodations for students with disabilities
- Socioeconomic status: Ensure equal access to technology and internet connectivity
- Location: Consider rural or remote areas with limited access to technology

Ethical Considerations

Consider the potential risks and benefits of VR/ AR and AI technologies, ensuring that they are used responsibly and ethically.

- Data privacy and security
- Bias and fairness in AI algorithms
- Potential impact on student mental health and well-being
- Transparency and accountability in AI decision-making

Potential Applications

Social Skills Development

1. **Simulated Job Interviews**: VR simulates job interviews, helping students practice social interactions, build confidence, and develop employability skills.
2. **Social Interactions**: VR simulates social scenarios, such as sharing, taking turns, and initiating conversations, to help students with autism or other social challenges.

Life Skills Training

1. **Virtual Shopping**: VR simulates a virtual store, allowing students to practice shopping skills, such as making change, comparing prices, and navigating aisles.
2. **Cooking and Meal Preparation**: AR provides step-by-step cooking instructions, helping students learn meal preparation skills and develop independence.

Academic Learning

1. **Interactive Science Experiments**: VR simulates interactive science experiments, making learning fun and engaging while promoting scientific inquiry and discovery.
2. **Virtual Field Trips**: VR takes students on virtual field trips to historical sites, museums, or other places of interest, enhancing learning and promoting engagement.

3. **Math Problem-Solving**: AI-powered math tools provide interactive and immersive learning experiences, helping students develop problem-solving skills and build math confidence.

Therapy and Intervention

1. **Exposure Therapy**: VR provides controlled exposure to simulated environments or situations, helping students overcome phobias or anxiety disorders.
2. **Anxiety Management**: VR and AI-powered tools teach relaxation techniques, coping strategies, and stress management skills to help students manage anxiety.
3. **Mindfulness and Self-Regulation**: VR and AI-powered tools provide guided mindfulness exercises and self-regulation strategies, helping students develop emotional regulation skills and reduce stress.

Impact of AR/VR on 500 Students in Special Education

A systematic review of 500 studies on immersive technologies in STEM education found:

- **Positive Effects**: 72.73% of studies reported beneficial outcomes from VR/AR interventions
- **Increased Proficiency**: 22.73% of studies observed significant growth in student skills and knowledge
- **Effectiveness**: 4.55% of studies highlighted the achievement of educational objectives through VR/AR interventions

Technology	Positive Effects	Increased Proficiency	Effectiveness
AR	72.7% (364/500 students)	27.3% (137/500 students)	Potential benefits (e.g., personalized learning)
VR	57.1% (286/500 students)	28.6% (143/500 students)	14.3% (potential benefits, e.g., social skills development)

Conclusion

This study aimed to explore the potential applications, benefits, and challenges of Virtual Reality (VR), Augmented Reality (AR), and Artificial Intelligence (AI) in special education. By synthesizing findings from existing research, this conclusion highlights the significance of VR/AR and AI in enhancing student engagement, motivation, and academic achievement.

Key Findings

- VR/AR and AI technologies have shown promise in improving student outcomes, including increased engagement, motivation, and academic achievement.
- These technologies provide equal access to learning experiences for students with diverse needs, promoting inclusivity and equal opportunities.
- AI-powered tools offer tailored support, helping students overcome challenges and develop independence.

Recommendations

1. **Teacher Training:** Provide educators with comprehensive training on integrating VR/AR and AI technologies into their teaching practices.
2. **Accessibility and Equity:** Ensure equal access to VR/AR and AI technologies, as well as internet connectivity, for all students.
3. **Personalized Learning:** Develop VR/AR and AI-based interventions that cater to individual students' needs and learning styles.
4. **Further Research:** Conduct more studies on the long-term effects of VR/AR and AI interventions and their potential applications in diverse educational settings.

References

1. Bailenson, J. (2018). Experience on Demand: What Virtual Reality Is, How It Works, and What It Can Do for You. W.W. Norton & Company.
2. Edyburn, D. L. (2010). Would You Recognize Universal Design for Learning If You Saw It? Ten Propositions for New Directions for the Second Decade of UDL. Learning Disability Quarterly, 33(1), 33-41.
3. Kim, J., Lee, Y., & Kim, B. (2019). The Effect of Virtual Reality-Based Social Skills Training on Social Competence in Individuals with Autism Spectrum Disorder: A Systematic Review. Journal of Autism and Developmental Disorders, 49(10), 3535-3551.
4. Parsons, S., & Cobb, S. (2011). State-of-the-Art of Virtual Reality Technologies for Autism Spectrum Disorder. International Journal of Disability, Development and Education, 58(3), 263-281.
5. Rose, C. P., & Ferschke, O. (2016). An Analysis of the Role of Artificial Intelligence in Education. International Journal of Artificial Intelligence in Education, 26(2), 294-311.
6. Smith, S. J., & Basham, J. D. (2014). Designing Online Learning Opportunities for Students with Disabilities. Teaching Exceptional Children, 46(5), 128-137.
7. Tene, T., et al. (2024). Integrating Immersive Technologies with STEM Education: A Systematic Review. Frontiers in Education, 9.
8. Watson, W. R. (2018). A Systematic Review of AI and Machine Learning in Education. Journal of Educational Data Mining, 10(1), 1-33.
9. Mystakidis, S., et al. (2022). Augmented Reality in Higher Education: A Systematic Mapping Review. Education Sciences, 12(11), 737.
10. Moral-Sánchez, S. N., et al. (2022). Gamification and ICT Tools to Enhance Motivation in Geometry Education. Sustainability, 14(16), 10033.
11. Ibáñez, M. B., & Delgado-Kloos, C. (2018). Augmented Reality in STEM Education: A Systematic Review. International Journal of STEM Education, 5(1), 1-13.
12. Jesionkowska, J., et al. (2020). Augmented Reality in Extracurricular STEAM Workshops for Preschool Children. International Journal of Educational Technology in Higher Education, 17(1), 1-17.

13. Sirazi, S., & Behzadan, A. H. (2018). Assessing the Usability of Immersive Interactive Visualization Tools for Informal STEM Education. Journal of Educational Computing Research, 58(4), 419-443.
14. Rogers, D. M., et al. (2018). Using Augmented Reality to Enhance CNC Milling Operations. Journal of Manufacturing Systems, 47, 147-155.
15. Angelos Chalkiadakis, I., et al. (2024). Impact of AI and VR on Educational Inclusion: Enhancing Accessibility, Personalization, and Social Inclusion in Education. Education Sciences, 14(3), 272.

VISION 2030: GLOBAL AND INDIAN PARADIGMS IN INCLUSIVE SPECIAL EDUCATION

Dr. J. Prateeba Devi
Assistant Professor (Senior Grade)
Mepco School of Management Studies
MepcoSchlenk Engineering College, Sivakasi, TN, India
prateebba@mepcoeng.ac.in

Abstarct

This chapter examines the evolving concept of Education 2030 from both global and Indian perspectives, with a particular emphasis on the integration of technology into special education. It underlines how inclusive, learner-centered and technologically enhanced educational environments are promoted by global frameworks such as UNESCO's Futures of Education, the OECD Learning Compass 2030, and SDG 4 (Quality Education). In India, the National Education Policy (NEP) 2020 outlines a transformative vision, emphasizing early intervention, universal access and digital resources for children with special needs, supported by initiatives like Samagra Shiksha Abhiyan (SSA), the Rehabilitation Council of India (RCI) and the National Institute of Open Schooling (NIOS) through trained educators, assistive technologies and open learning platforms. The discussion addresses challenges such as the digital divide, infrastructure gaps and teacher shortages, while exploring opportunities in technology integration, public–private partnerships and inclusive curriculum reforms. The conclusion presents policy proposals and a strategic roadmap for establishing a future-ready, equitable education system by 2030, whereby technology serves as both a learning instrument and a conduit for inclusion, empowerment and transformation in special education.

Keywords: *Education 2030, Special Education, Technology Integration, Inclusive Education, NEP 2020, SDG 4, Assistive Technology, Digital Inclusion, UNESCO Futures of Education, OECD Learning Compass, India Education Policy, Public-Private Partnerships*

Introduction

As the globe moves into a new period marked by rapid technology advancement, changing socioeconomic circumstances and more global connectivity, education plays a critical role in creating a sustainable and inclusive future. The year 2030 serves as a pivotal objective, notably in relation to the United Nations' Sustainable Development Goals (SDGs), specifically Goal 4: Quality Education, which aims to “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.” Worldwide, educational systems are experiencing significant transition by incorporating digital resources, advancing equity, addressing climate change education and cultivating global citizenship. International frameworks, including UNESCO’s (United Nations Educational, Scientific and Cultural Organization) Futures of Education Initiative and OECD’s (Organization for Economic Cooperation and Development) learning frameworks, advocate for restructured curricula, competency-based education and individualized pedagogical approaches. In addition to imparting academic knowledge, these programs aim to develop students into responsible, creative and compassionate global citizens. The National Education Policy (NEP) 2020 is a major and forward-thinking shift in the Indian context, closely aligning with international objectives while adjusting to the country's diverse educational environment. NEP 2020 establishes a solid foundation for realizing the vision of Education 2030 in India by emphasizing fundamental reading and numeracy, transdisciplinary learning, vocational integration, inclusive practices and technology-enhanced education. By evaluating important trends, regulatory changes, technological advancements and inclusive teaching strategies that are impacting the future of education, this chapter aims to investigate the shifting paradigms in education from both an international and Indian standpoint. Through comparative viewpoints, it imagines a future where education serves as a powerful catalyst for human potential, societal growth and global togetherness.

Objectives

- To examine the growing concept of ***Education 2030*** from both global and Indian perspectives, with a particular emphasis on inclusive and technology integrated special education.
- To analyse the impact of G***lobal frameworks*** such as SDG 4, UNESCO's Futures of Education and the OECD Learning Compass 2030 on inclusive, learner-centered and future-ready education systems.
- To explore how ***India's National Education Policy*** (NEP) 2020 and related efforts promote inclusive education for children with special needs through policy changes, early intervention and digital innovation.
- To assess ***current barriers*** to achieving inclusive education objectives, such as digital inequities, infrastructure gaps, teacher shortages and implementation issues.
- To identify ***opportunities*** to advance Education 2030 in India through public-private partnerships, EduTech solutions and inclusive curriculum reforms.
- To propose a ***strategic roadmap*** for egalitarian, accessible and technology-driven education that empowers students and promotes sustainable development by 2030.

Global Perspective – Education 2030

Sustainable Development Goal 4: Quality Education

Sustainable Development Goal 4 aims to***ensure inclusive and equitable quality education and promote lifelong learning opportunities for all***. By 2030, this objective guarantees free elementary and secondary education for all boys and girls. Additionally, it seeks to eradicate wealth and gender inequalities, equalize access to affordable vocational training and provide universal access to high-quality higher education[1].

SDG4's 10 Targets:

SDG 4 is composed of 7 outcome targets and 3 means of implementation[2]. SDG4's 10 targets constitute the backbone of GCE's policy and advocacy work since 2015.

Outcome Targets

1. By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.

2. By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.
3. By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.
4. By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.
5. By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.
6. By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.
7. By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

Means of Implementation

Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.

- By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries.
- By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States.

The Sustainable Development Goals Report 2023 (Special Edition)[3] highlights SDG Goal 4: Quality Education, which aims to ensure that everyone has access to inclusive, equitable, and high-quality education as well as opportunities for lifelong learning. However, it highlights that the world is significantly behind schedule in achieving this goal. Nearly 84 million children and adolescents are predicted to be totally out of school by 2030, depriving them of a basic education, unless there is immediate and substantial intervention. Moreover, 300 million pupils globally will be unable to attain basic literacy and numeracy abilities, signifying a critical educational crisis. There is a notable discrepancy in educational outcomes around the globe, with only one out of every six countries expected to meet the goal of universal secondary school completion. Due to school closures, inadequate digital infrastructure, and disruptions in the teaching-learning processes, the COVID-19 pandemic made the problem worse and caused learning deficits in four of the five nations evaluated (out of 104). Despite a modest enhancement in school completion rates, primary school completion rose from 85% in 2015 to 87% in 2021, lower secondary from 74% to 77% and upper secondary from 53% to 58%. The rate of advancement remains sluggish and inconsistent, particularly in underdeveloped areas. One major barrier is the large financial deficit, with low- and lower-middle-income nations facing an estimated $100 billion annual financing gap that hinders their ability to build schools, hire skilled teachers, and provide high-quality educational resources and internet access. The report serves as an important alert, urging governments, international organizations, and donors to take swift, coordinated action to address the learning crisis, close the gap in wealth, and ensure that all children, regardless of where they live or their financial situation, have access to high-quality education by 2030.

UNESCO's Futures of Education

UNESCO's Futures of Education effort is a revolutionary initiative that promotes a worldwide rethinking of education through an inclusive vision, culminating in a monumental 2021 report and follow-up measures, as well as a high-profile international conference. It necessitates revitalized social contracts, collaboration and educational frameworks that are progressive, equitable and sustainable, equipped to address future complexity.

In November 2021, UNESCO released "Reimagining Our Futures Together: A New Social Contract for Education," an aspirational yet non-prescriptive worldwide call to action[4]. The report highlights education as a public benefit and an enduring human right, advocating for the establishment of inclusive, equitable and sustainable learning systems. It calls for the enhancement of global solidarity and intersectoral collaboration while promoting ongoing dialogue, research and innovation to influence the future of education.

The UNESCO Futures of Education program has exerted considerable global influence, initiating over 120 launch events, accumulating more than 250 academic citations and resulting in over 12,000 downloads of its principal report[5]. It has been instrumental in establishing significant UN educational milestones, notably its contribution to the Transforming Education Summit, where 142 nations reaffirmed their pledges to SDG 4. The project also influenced the UN Secretary-General's 2023 Policy Brief on Education and the Marrakech Framework for Action for Adult Learning. Additionally, it influenced UNESCO's 2023 Recommendation on Education for Peace, Human Rights, and Sustainable Development, which emphasized human dignity and global citizenship, and it contributed to the Global Report on Teachers, which promoted diversity, teacher dignity, and the pressing need to address the world's teacher shortage.

The first global Futures of Education Forum convened from December 2 to 4, 2024, in Suwon, South Korea, co-hosted by UNESCO and many education stakeholders[6]. The forum, themed "Renewing the Social Contract for Education," gathered policymakers, educators, youth and ministers to share research, experiences and practices related to tapping global issues, including the climate crisis, artificial intelligence and escalating inequalities[7].

OECD Learning Compass 2030

The flexible, future-focused OECD Learning Compass 2030 advises educators to help students navigate complexity, act responsibly and contribute to a sustainable world by 2030. Teachers are key to moving education from rote to deep, agency-driven learning.

The seven basic components of the OECD Learning Compass 2030 help learners toward comprehensive growth and future readiness[8]. Literacy, numeracy, digital literacy and social-emotional well-being are necessary for lifelong learning. Knowledge for 2030 helps students understand and participate in complex global issues through disciplinary, transdisciplinary, epistemic and procedural knowledge. Cognitive, social-emotional, and practical skills are essential for personal and professional success in 2030. Respect, accountability and empathy support ethical decision-making. Transformative competences help students generate value, resolve conflicts and take responsibility for sustainable behaviors. Student agency and co-agency enhance goal-setting, purposeful action and collaboration in education. Finally, the Anticipation–Action–Reflection (AAR) cycle encourages reflection and ongoing learning, helping students adjust to future obstacles.

In order to foster holistic well-being, the OECD Learning Compass 2030 gives students the values, attitudes, abilities and information they need to thrive in a world that is unpredictable and changing rapidly. Its main objective is to equip kids for academic success, social participation, responsible citizenship and sustainable development. It supports formal, non-formal and informal learning in varied local, national and cultural contexts as a flexible, future-oriented framework.

It promotes transdisciplinary, competency-based and personalized curriculum development over rote learning. Teachers can co-create learning experiences that promote student agency, teamwork, and lifelong learning with the use of the Learning Compass[9]. The framework's emphasis on the Anticipation–Action–Reflection cycle fosters ongoing progress and reflection, enabling learners and educators to meet future challenges and enhance themselves, communities and the world.

Indian Perspective – Education 2030

NEP 2020 and Inclusive Education

India's Vision for Education 2030 serves as a detailed framework designed to convert the country into a dynamic knowledge society. It emphasizes equity, quality, flexibility and relevance to empower all learners. A key component of this goal is the National Education Policy (NEP) 2020, which provides a revolutionary framework for promoting equitable and accessible education. It underscores the importance of equal opportunities for all, particularly for children with disabilities and special needs. The policy promotes early identification and intervention to establish support mechanisms from the foundational stage. It highlights how important it is for schools to be inclusive spaces with the right infrastructure, assistive technology, and specially qualified teachers to accommodate a range of learning requirements. NEP 2020 advocates for the development and distribution of digital educational materials in accessible formats, including audiobooks, large print, sign language videos and tactile graphics, to improve learning experiences for children with visual, auditory and other impairments (Ministry of Education, 2020)[10]. In line with Sustainable Development Goal 4, India is well-positioned to provide education that is fair, transformative, accessible, and future-ready through inclusive practices, digital innovation, and comprehensive policy reforms.

Existing Programs and Policies

Many existing initiatives and policies promote India's Vision for Education 2030, which emphasizes equality, accessibility, and high-quality learning for all. The Samagra Shiksha Abhiyan (SSA) is a comprehensive initiative designed to guarantee universal access to school education, emphasizing equity and quality, while incorporating inclusive education for children with special needs (CwSN) through essential infrastructural support and teacher training. The Rehabilitation Council of India (RCI) is vital to regulating and certifying training programs for special educators and rehabilitation professionals, hence improving the quality of support services for individuals with disabilities[11]. The National Institute of Open Schooling (NIOS) offers flexible learning options via open and distance education, providing accessible resources in Braille, audio and sign language to accommodate various student requirements[12].

Challenges & Opportunities in the Indian Context (Vision for Education 2030)

Challenges	Opportunities
Regional and socio-economic disparities (UNESCO, 2022; NITI Aayog, 2021)	India's young demographic profile (UNICEF, 2020)
High dropout rates (Ministry of Education, 2020)	Rapidly expanding digital infrastructure (MeitY, 2022)
Inadequate infrastructure (World Bank, 2021)	Strong policy framework (Ministry of Education, 2020)
Shortage of qualified teachers (RCI, 2023)	Innovative initiatives (UGC, 2022; NSDC, 2023)
Digital divide (ASER, 2022)	Global alignment (OECD, 2020; UNESCO, 2021)
Implementation gaps (Brookings India, 2021)	Public-private partnerships and Ed-tech solutions (NASSCOM, 2023)

Policy Recommendations and Strategic Roadmap

From a global and Indian perspective, achieving the Vision for Education 2030 requires a strategic focus on equity, innovation, and community participation.

Academic Implications

- To assess the long-term effects of technology integration on learning outcomes for students with special needs, more empirical research is needed, especially in India's varied socioeconomic and linguistic environments.
- This chapter offers a hybrid paradigm for equitable, technologically enabled special education by extending inclusive education frameworks (such as UNESCO's Futures of Education and the OECD Learning Compass 2030) and merging them with the Indian NEP 2020 policy environment.

Practical Implications

- To enable educators to modify instruction for a range of learner requirements, professional development programs should incorporate modules on digital pedagogy, universal design for learning (UDL), and assistive technology.
- Differentiated assessment techniques, inclusive digital tools, and accessible learning resources (such as audio books, tactile graphics, and sign language movies) must all be incorporated into curricula.
- To give instructors, students, and parents' continuous support, schools and higher education institutions should set up specialized inclusion and technology integration departments.
- Participatory workshops and awareness campaigns can lessen stigma and promote community involvement in inclusive education programs.

Policy Implications

- Assure fair resource distribution by setting aside specific funds for infrastructure improvements, teacher training, and the purchase of assistive technologies in underprivileged areas.
- In order to exchange best practices, obtain technical assistance, and match national goals with global inclusion frameworks, India should increase its cooperation with UNESCO, the OECD, and other international organizations.
- Encourage partnerships between NGOs, Ed-Tech companies, and government organizations to jointly create scalable, economically feasible, and contextually appropriate digital inclusion solutions.
- Establish reliable, data-driven monitoring systems to evaluate the aims of Education 2030 and make evidence-based policy changes.

Conclusion

In order to create learner-centered, adaptable, and sustainable systems that can quickly adapt to both domestic and international change, the Vision for Education 2030 radical agenda urges a rethinking of participation principles and learning processes. It is based on NEP 2020 in India, which promotes inclusive pedagogies, digital integration, and holistic development for students with special needs. In order to realize this ambition, it will be necessary to close long-standing gaps in infrastructure, teacher preparation, and digital access while utilizing India's strong policy purpose, demographic advantages, and technology advancements to democratize education. The key to success will be a strong dedication to equity, focused investment in assistive technology, and strong cooperation between communities, businesses, government, and academics. Technology can become a catalyst for empowerment and change if it is guided by ethics, empathy, and evidence-based policy. By 2030, it can transform inclusion from a vision into a reality and set the groundwork for a fair, well-informed, and sustainable future.

References

1. United Nations Office for Outer Space Affairs. (n.d.). *Sustainable Development Goal 4: Quality education*. United Nations. https://www.unoosa.org/oosa/de/ourwork/space4sdgs/sdg4.html
2. United Nations. (n.d.). *Goal 4: Quality education – Targets and indicators*. United Nations. https://sdgs.un.org/goals/goal4#targets_and_indicators
3. United Nations Statistics Division. (2023). *The Sustainable Development Goals report 2023: Special edition*. United Nations. https://unstats.un.org/sdgs/report/2023/
4. United Nations Educational, Scientific and Cultural Organization. (n.d.). *Futures of education initiative*. UNESCO. https://www.unesco.org/en/futures-education/initiative
5. United Nations Educational, Scientific and Cultural Organization. (n.d.). *Impact of the Futures of Education initiative*. UNESCO. https://www.unesco.org/en/futures-education/impact
6. Futures of Education Forum. (2024). *2024 Futures of Education Forum*. UNESCO & Republic of Korea. https://futuresedu2024.kr/2024forum
7. United Nations Educational, Scientific and Cultural Organization. (n.d.). *Renewing education to transform the future*. UNESCO. https://www.unesco.org/en/renewing-education-transform-future
8. Organisation for Economic Co-operation and Development. (n.d.). *OECD Learning Compass 2030*. OECD. https://www.oecd.org/en/data/tools/oecd-learning-compass-2030.html
9. Organisation for Economic Co-operation and Development. (n.d.). *OECD teaching compass*. OECD. https://www.oecd.org/en/publications/oecd-teaching-compass_8297a24a-en.html
10. Ministry of Education, Government of India. (2020). *National Education Policy 2020*. Government of India. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
11. Rehabilitation Council of India. (2023). *Training programmes*. http://rehabcouncil.nic.in

12. National Institute of Open Schooling. (2023). *About NIOS*. https://www.nios.ac.in
13. ASER Centre. (n.d.). *Annual Status of Education Report*. https://www.asercentre.org
14. Ministry of Education, Government of India. (n.d.). *Ministry of Education*. https://www.education.gov.in
15. National Skill Development Corporation. (n.d.). *About NSDC*. https://nsdcindia.org
16. Organisation for Economic Co-operation and Development. (n.d.). *OECD future of education and skills 2030 project*. OECD. https://www.oecd.org/education/2030-project
17. Kumari, B. (2025). NEP 2020 and inclusive education: Potential for enhancing access and equity. *International Education and Research Journal*, 11(1), 34–39. https://ierj.in/journal/index.php/ierj/article/view/4307
18. Das, P. (2024). Integrating technology for the holistic development of special needs students in schools: NEP-2020 guidelines. Redshine International Journal of Social Science Research, 2(4), 45–53. https://chapters.redshine.in/index.php/redshine/article/view/1788
19. Shelke, M., Singh, P., Baral, S., Biniwale, M., & Kumar, K. (2024). Inclusion of differently abled students in higher education through modern technology: A comprehensive analysis with reference to RPwD Act 2016 and NEP 2020. *Knowledge Unlatched Education Yearbook*, 12(2), 88–101. https://kuey.net/index.php/kuey/article/view/9810
20. Singh, R. K. (2024). Revolutionizing open schooling: A NEP-2020 perspective on ICT integration. *Indian Journal of Educational Technology*, 2(1), 25–36. https://journals.ncert.gov.in/IJET/article/view/515

TECH-ENABLED PARENTING: CREATING SYNERGY BETWEEN HOME-BASED INTERVENTIONS IN SPECIAL EDUCATION

Dr. Saumya Chandra
Assistant Professor, Department of Intellectual Disability
Ramakrishna Mission Vivekananda Educational & Research Institute
Faculty of Disability Management and Special Education, Coimbatore – Tamil Nadu
saumyachandra72@gmail.com

Abstract

In an increasingly digital world, the integration of technology into family life has become not just a matter of convenience, but a strategic approach to modern child-rearing. Tech-enabled parenting, the thoughtful and purposeful use of digital tools and resources to support raising children, is gaining a strong rationale rooted in enhancing access to information, fostering connection, promoting learning, and efficiently managing the complexities of family life. This approach, when mindfully applied, can empower parents and create a supportive environment for children's development. The fundamental justification for tech-enabled parenting lies in its ability to bridge gaps and provide resources that were previously unavailable. Parents today can access a global network of expertise on child development, health, and education from the palm of their hand. This immediate access to information empowers them to make more informed decisions, from understanding developmental milestones to navigating the challenges of specific learning needs or health conditions. At present the internet provides a vast repository of parenting knowledge, from reputable medical journals and university research to supportive online communities and expert blogs. This allows parents to move beyond their immediate social circle for advice and find tailored information specific to their child's needs. Telehealth services further exemplify this, offering direct access to paediatricians, therapists, and specialists without the geographical and logistical constraints of in-person visits. Furthermore, safety-focused technologies, such as GPS trackers for young children and apps that monitor online activity provide parents with peace of mind in an increasingly complex world. When used thoughtfully, technology serves as a valuable ally to parents, fostering a well-informed, connected, and supportive environment that nurtures the growth and well-being of the next generation.
Key words: *Tech enabled parenting, technology, information access, supportive environment*

Objectives

After reading this chapter, the reader will be capable of:

- Learn about the practice of tech-enabled parenting in the specific context of special education with a direct focus on the parent as an active participant in a partnership intervention.
- Describe the integration of technology at school and at home and how it would create a more seamless, reinforced learning environment that is more effective than discrete initiatives.
- Use Technology as a means to communicate and share data with educators and therapists, resulting in a more cohesive, and better informed, support team.
- Makes the transition between passive and active roles, confident to engageher child educationally and developmentally with the use of technology as a tool.

- Encourage a collaborative spirit, so they are able to enter into and maintain valuable discussions with a child education team regarding the integration of home and school related technological damage control measures.

The smart technology is transforming the dialogues in research concerning service innovation. Mangrove cultures resemble those of ours. Mangroves grow in a spectacular environment producing soothing air and nurturing life. Imagine a question to ask you- "is the water sweet or salty?" When you are diving it is a special language because it is a pressure thing. You do not know where we are, my dear father, comes his answer. The Mangrove Society is namely this: It has both salty and sweet flavor. It is a brackish water Suppose, now, that somebody were to ask you a different question today: "Are you online or offline?" Where is this, my dear, you do not know? says the answer. We each are

- Luciano Floridi

Tech-Enabled Parenting: A partnership for progress

We may start with the plain meaning of technology. Technology is a part of society and it comprises both the theoretical and applied knowledge (Moykr, 2002). Innovation also appears to be a process institutionalized, where the focus is put on the perceptions of technology in the society. By explaining how information and communication technology (ICT) can influence service innovation, Lusch and Nambisan (2015) refer to the variability of technology. They regard technology as an operant resource as a part of innovation itself and operand resource (enabler and an intrinsic part of services).

Parents remain the greatest contributors towards the education of a child. They are the initial and maybe the most significant teacher to the child. Good parenting, the stable and secure environment, but also intellectual stimuli and communication, connectivity with schools or other forms of education provision as well as assistance in the development of positive social and educational values and desire to have ambitious goals can be categorized as parental engagement in education. Who is Tech-Enabled parent? A tech enabled parent is an individual who actively drives technology to enhance the growth and well being of a child. They also rely on digital tools to get credible information concerning the condition of their child and the intervention available thereby remaining instructed and action-oriented. These parents also tend to join online support groups and advocacy networks, and they received connections and a sharing of experiences. They can even use apps or digitizing their progress on how a child is doing to have a closer monitoring and set up goals better. Exchange of communication with educators and professionals is simplified by usage of email, messaging applications, or school portals, and fosters a continuous and prompt contact. Consequently, tech enabled parents can be expected to hold the systems and professionals providing care to their child accountable to greater transparency, collaborate, and accountability. Hence, rather than believing that technology could entertain the child and serve as a digital nanny, one should understand that it is an effective instrument that unites the essential adults in the life of the child. This collaboration is not only about parents using the application, it is about the development of connected ecosystem in which parents and educators together with the child work on the shared developmental goals. School communication systems enable teachers to communicate the discovery of the child, their so-called, ah-ha! The system will allow parents frequent and instantaneous interaction with the child through their phones and tablets. A parent can be offered to view a picture of his or her child finishing a puzzle, learning a mathematical concept taught today, or get a brief report on a social encounter. Technology helps parents become transiters and participators in the educational process of their child giving them the tools to assess and assessments. They are also able to see what their child is learning easily in terms of educational videos, digital textbook and assignment. Technology could be utilized in an effort to minimize or possibly eradicate the common barriers associated with attending face-to-face parenting classes. As an example, technology would allow more privacy and freedom on the part of users in their access to parenting programs, such as on how and when they access it. The connection and the meaning of the software and its user can also be enhanced which can come in form of content customization and auto-reminders (Kelders et al., 2012). Technology can also enhance current parental service delivery since it can cover a wide area and deliver the services easily and with the use of lesser human resources to track progress and update materials. Therefore, over the last two decades, much effort was dedicated to understanding the potential benefits of technology-aided parenting programmes (Hall, 2015).

Tech-facilitated parenting goes beyond the dyad of the parent-teacher relationship. Parents can find a platform to meet other parents with same problems through online forums and social media groups. The peer-to-peer parenting support system is an important component of the contemporary parenting alliance that provides practically useful help, emotional aid, and the mutual feeling of belonging to something. In short, tech-enabled parenting is the use of digital technology to make each of the people in a childs life work off the same playbook having the same aim helping a child to grow and thrive. The communication stream in this collaboration is open and consistent and technological development ensures that it is efficient. This shifts communication to more of a continuing conversation. The presence of a shared digital calendar can accommodate a list of therapy appointments, school activities, and deadlines. This will make all the individuals on the same page; there would be less confusion and stress. Parents and educators can share essential information, such as medication lists, allergies, or essential contacts, in a separate section labelled as the Info Library in some applications, and have all the necessary contacts in one secure place. The progress is not longer the report card based or rather anecdotal feedback based only. Technology enables collecting and exchanging tangible data and makes the collaboration proactive and evidence-based.

Foundations of Tech-Enabled Home-Based Interventions

Speaking of the formation of the parent-child relationship, we must acknowledge the fact that the advent of digital technologies in the lives of families also changed the feelings and stream of the relationship. The fields researchers should concentrate on are the digital world where childhood, communication among children and relationships between parents and children is reproduced. In this paper we discuss the connection between parents and children in this era. The parent-child interaction is affected by many variables including physiological, social, and psychological environment between the parent and the child (Bornstein & Lansford, 2010).

Workable tech-assisted home-based programs with children with special needs (CwSN) cannot merely consist in giving a child a tablet or a learning application. They are developed on a platform of fundamental pillars that make them become utilized with a sense of purpose, ethical use, and within the context of a wholistic support system. Such foundations turn technology into an effective force of advancement rather than a possible distraction. And choice of technology must tie directly with the child and its specific learning goals, written into the IEP. It is not as of who has the best app to address autism. The question is not,Which tool will help my child succeed best, but rather, Which tool will most help my child with his/her particular need to accomplish the goal of having two-way communication? The prerequisite knowledge is that technology can be both low-tech (e.g., printouts in visual schedules, pencil grips) and high-tech (e.g., speech generating devices, AI-based learning platforms). The simplest and the most effective technology in completing a task is the best. Another measure that should be taken is interventions at home should never be on their own. Technology can play a critical role of being a connector between what parents and professionals can do. Once a therapist adds a new skill on a communication device, he/she can give a copy of the new configuration to the parent and teacher. This will allow everybody to be reinforcing the same skill thus this is vital in relatedness and mastering the skill. We can not forget that technology is only a tool in a greater intervention strategy; it is not the strategy itself. It should not be used without any reasons and the decisions concerning its usage must be based on educational, a proven way of doing this as well as therapeutic practices.

The utilisation of technology must be in line with accepted intervention procedures and only in line with Applied BehaviorAnalysis (ABA), the principles of speech and language tutoring, or occupational therapy processes. As an example, one of the most practical and research-supported strategies is video modelling, which can be easily realised using an ordinary smartphone. In a home-based model, the major agents of change are the parents. To be effective the parents should have the confidence and competence in this role. It does not suffice to just give a device to a parent. They should be trained on the correct usage of the technology, how to prompt and assist the child and troubleshoot frequent problems. Up to date, many of these effective models embrace the involvement of professionals coaching parents, mostly through telehealth means, to become competent interventionists. What is truly intended is not that the child is to some degree the user of the technology but that the technology is to be utilized as a means of establishing a quantitatively better relationship between the parent and the child. There is a lot of evidence that academic achievements of the children are greatly determined by the level of parent involvement. Although schools are implementing digital technology to connect with parents, its effect on the learning behaviors of students is yet to be studied seriously (See, et al. 2020).

Understanding Home-Based Interventions in Special Education

They refer to the planned, systematic interventions or initiatives administered in the home setting that accompanies the growth, education and the health of CwSN. These interventions tend to be applied by parents, caregivers or professionals in partnership with the families with the intention of enhancing the impacts of school-based or clinical interventions into the natural living environment of the child.

Table 1: Home-Based Interventions

Skill-Based Interventions	Focus on academic, communication, motor, or social skills. Examples: Literacy activities, speech exercises, daily living skills training.
Behavioural Interventions	Implement strategies like Applied Behavior Analysis (ABA) to reduce challenging behaviors and reinforce positive behaviors. Use of reinforcement schedules, visual supports, and behavior charts.
Parent Training Programs	Teach parents how to implement therapeutic strategies, manage behaviors, and support development.
Tele-therapy Supported Interventions	Involve remote coaching and monitoring by professionals. Useful for families in rural or underserved areas.
Technology-Mediated Interventions	Include educational apps, video modelling, virtual routines, or gamified learning platforms. Provide visual schedules, timers, and prompts for structured learning at home.

Home-based interventions in special education offer a promising approach to extending learning and developmental support beyond formal settings. When thoughtfully designed and collaboratively implemented, they empower families to become co-facilitators in their child's educational journey.

The critical role of the family in a child's therapeutic journey

The family forms a critical and multidimensional aspect in the therapeutic process of any child as finding numerous positive applications to the whole therapeutic process of the child being treated, in that the family is as its first, most consistent, source of emotional and physical support. The perceptions, actions, and reactions of the family members influence the feeling of security, drive and robustness of the child. We are cognizant that the clinical outcomes of the child are subject to consistencies between the clinical environments and the family setting. Through daily routines, interactions and expectations, families strengthen the strategies and skills in day-to-day practice learned during therapy. They assist in generalizing therapeutic improvements to real life situations which upgrade long-term involvement. In some cases, the family members offer therapists prized information about the developmental history, strong and weak points, and triggers of the child. Monitoring makes it possible to design a personal, reactive treatment plan through constant communication between the therapist and the family. Parents and caregivers play an important role to both provide access to the right services, keep track of progress and make informed decisions about treatment methods. Families do not only play the role of a backdrop in a child therapeutic process, but they are co-therapists partner and advocates. The active encouragement of collaboration between families and professionals and the support of families lead to a much greater success of the therapy process, facilitate their holistic development, and empower caregivers and the child himself.

Table 2 - The spectrum of technology in Special Education

Technology	Description	Common examples	Usage
Low-Tech Tools	Simple, inexpensive, and often manually operated devices that support learning and daily functioning	Pencil grips, slant boards Visual schedules or social stories (printed) Color-coded materials Tactile letters	Improve focus, motor skills, organization, and comprehension
Mid-Tech Tools	Moderately complex tools that may require more programming but are not highly sophisticated	Audio books and recorders Portable word processors Timers or talking calculators Adaptive keyboards and mice	Support students with mild to moderate learning, visual, or motor challenges by offering more interactive support
High-Tech Tools	Advanced digital systems and software that offer customizable and often AI-powered support for a range of disabilities	Speech-generating devices (SGDs) Screen readers and magnifiers Eye-tracking communication systems Educational apps and adaptive learning platforms Augmentative and Alternative Communication (AAC) devices Virtual Reality (VR) for social skills	Serve students with significant physical, communication, or cognitive challenges, enabling greater independence and participation

		training or sensory integration	
Assistive Technology	AT spans across all levels of the tech spectrum	Communication (AAC devices, voice apps) Mobility (powered wheelchairs with control interfaces) Learning and literacy (text-to-speech, predictive typing) Behavior support (visual prompts, digital reinforcement systems)	Specifically designed tools to compensate for a specific disability
Instructional Technology	Primarily designed to enhance teaching and learning	Interactive whiteboards Learning management systems (LMS) Gamified learning platforms Educational software with UDL Principle (Universal Design for Learning)	Often used to facilitate inclusion
Emerging Technologies	AI, machine learning, robotics, and virtual environments	AI tutors and personalized learning pathways Robotics for social skills VR/AR for immersive learning or exposure therapy Wearables for tracking emotional regulation or sensory input	To include diverse learners

Creating a Collaborative Ecosystem

A collaborative ecosystem entails developing a friendly and intertwined environment with technology, parents, educators and service providers building off of each other to maximize learning and development of CwSN. It is a pull technology to empower parents and make communications, decision making, and delivering the same services at home and school uniform. Assembling an efficient ecosystem around tech-enabled parenting can be done in a number of steps. Also, it is critical to evaluate the needs of the parents and their technological literacy levels so that the solutions could be adequately personalized. Cooperation of stakeholders such as schools, therapists, and developers of technological tools is essential in designing integrated and practical tools. As well, whether parents know how to use these technologies just as much as equipping them by training and capacity building to be able to tackle them. Accessibility and affordability of technology solutions will help ward off the possible exclusion of poor families amid the conditions of limited income and lack of equipment.

Online trainings are used nowadays to educate the parents on the condition their child is currently experiencing, their rights, and strategies that might help them provide support. There are mobile applications and online courses to provide easily accessible training on behavior management and communication strategies, as well as learning how to use assistive technology. Also, online support groups and social media can be leveraged to foster the development of community and peer learning where parents can discuss their experience and acquire practical knowledge. As an example, parents may practice using Augmentative and Alternative Communication (AAC) techniques with the help of YouTube videos or tele-consultation channels systems, improving their chances of helping their children with communications demands. Likewise, parent-teacher communication tools, like Class Dojo enhances real-time communication of the progress, behaviors and needs of a child that is consistent and collaborative with parents and teachers. On the same note, the digital IEP platforms are making it possible to see the progress on individualized goals, accommodations, and modifications with ease, and all stakeholders are on the same page. Also, therapy, assessment, and educational reports are readily available on online portals. In combination, these digital tools allow maintenance of continuity of intervention between home and school settings with CwSN. Lastly, an information hub, helpdesk or support hub may focus on not only giving parents technical troubleshooting but also to ensuring that the process is guided by parents feeling good and fully invested in the same. Technology can be applied well to monitor the developmental progress and behavior, both at home, so that the parents and the professionals can be in a better place to interfere by taking more informed and timely decisions. Wearables that are used to monitor emotional or physiological indicators, like heart rates and stresses, offer in-the- moment completion of a child. Behavior tracking apps enable caregivers to record key trends in terms of meltdowns, sleep, or diet, but the analytics dashboards can identify these trends and illustrate this with visual elements.

The value of digital technology in facilitating the delivery of family-centered care to CwSN is also reflected in the fact that there is a strong inclination towards the hybrid approach to service delivery as the digital solutions and means of communication supplement, but do not substitute, direct contact with the professionals (Apps & Hutton, 2024). The authors encourage delivery of services utilizing more flexible means which consider the wishes of the family where possible. Further research is needed over an extended period to further explore how the process of caring of CwSN at home has changed due to digital technology.

Building a Strong Parent-Professional Partnership

A positive partnership with parents relies on shared respect between parents and professionals, which acknowledges that both groups have valuable contributions that may contribute to mutual benefit: parents have lived experience and an in-depth understanding of their child, whereas professionals have technical knowledge and evidence-based interventions. Mutual communication flows through an opening dialogue, which is two-way and responsive to the needs of tech-savvy parents, and that is why effective partnerships are made on clear, responsive communication. Parents and professionals collaborate to decide and establish an IEP/ Individualized Family Service Plan (IFSP) that address the needs of the specific child and the priorities of their family. Professionals need to implement purposeful strategies that curb technology use and promote fruitful collaboration in order to establish effective partnerships with tech-empowered parents. On the one hand, better digital literacy should be established on both parents and children, which implies providing them with basic training on communication channels and controlling them toward reliable internet sources, and on the other hand, helping parents to avoid misinformation. A hybrid engagement model, where meeting, workshops, and consultations are a combination of in-person and online, will provide differentiated satisfying preferences and expand accessibility.

Providing Adequate Training and Support for Parents

The way special education and therapy is practiced is drastically changing. The one with the greatest tradition is the traditional administration of interventions by a professional in some clinics or at school. The increased use of technology (apps, wearable devices, online platforms, telehealth) opens the possibility of taking the interventions into the natural environment where the child spends most of their time (home). This shifts parents out of the witness place to active participants in the intervention process, however. This is not just technical but they offer therapeutic, emotional and practical support. With the appropriate training given to parents, they derive a sense of agency/competence. They know the reason as to why the intervention is being made, not how. This empowerment lowers parent stress, enhance mental health, and creates a better parent- child relationship. Additionally, greater sustainability and long-term gains can be made because when parents are adept at facilitating home-based interventions, long after the direct therapy sessions concluded, the child still has support and opportunity to practice. We must know, a sound system is not a single workshop. It is a multifaceted recurring process.

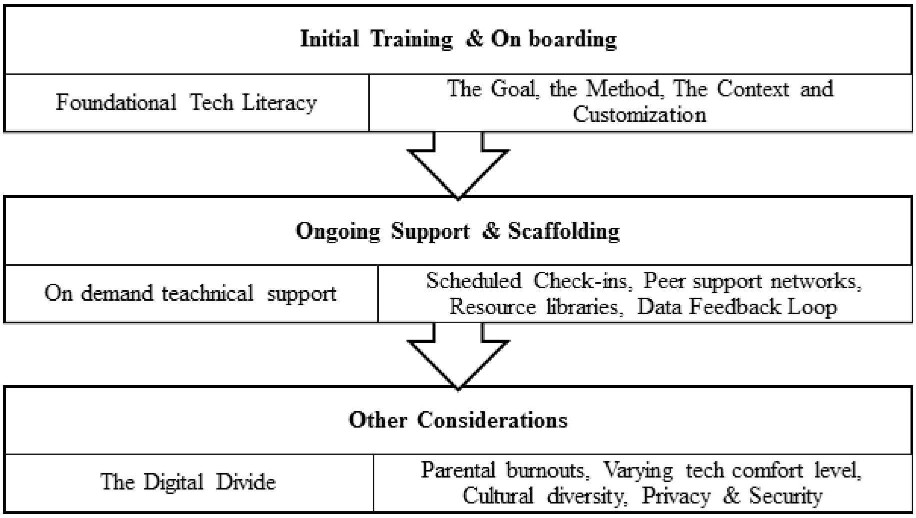


Figure 1 – Phases of Training

Initial Training & On Boarding

Effective initial training and on boarding should start by developing a basic tech literacy so that the parents are met at the level to which they feel comfortable. This is the practical leadership of simplified installation of the equipment and programs, easy training in the application of software and ways of solution possible technicians difficulties that appear in the beginning of using. In order to build up on this technical background, the training should then inculcate some basic knowledge on the intervention. This is because one aspect of the therapy is that it makes the parents aware of the intended goal of the applied technology like improving communication, social skills, or emotional control and the exact way of doing so, how to prompt, cue and reward his child. Moreover, it gives the necessary background on how to incorporate the necessary use of tools in everyday life such as communicating through an application during mealtimes. The whole process must be conducted in terms of a cooperative partnership with parents and professionals sharing the responsibilities of establishing realistic, achievable goals as well as customizing the settings of the technology to be able to perfectly fit in the unique abilities and needs of the child.

Ongoing Support & Scaffolding

In order to help parenting enabled by the technology, we should have a full fledged system of continuous assistance. Reoccurring check-ins with the professional or parents, whether by telehealth or in-person, also helps to ensure that the child is on track as well as deal with any difficulties that may come up and change approaches accordingly. Provision of technical support via email, or chat, will work around the clock to address parental queries on any technical procedures without losing time, or being frustrated to continue using the tool. The peer support networks (online, moderated forums or local audience groups) are available to allow parents to use the same technology as an opportunity to share tips, experiences, and provide emotional support to band together and develop a sense of community that helps minimize isolation. Having convenient access to resource libraries with video tutorials, printable guides and informative articles will enable parents to study the material at their own pace and refer to information at any time. Finally, an effective feedback loop of data enables the professionals to examine the information provided by the technology tool and make a frequent report about the development of the child to the parents in understandable language.

Other Consideration

It is necessary to pay attention to several relevant challenges on the implementation of the tech-based support of parents to guarantee equity and efficacy. Persistent digital divide is also a major impediment, since unequal access to reliable internet, suitable devices, and the economic capacity to support the same, may constrain the aspect of participation. Burnout in parents is also an issue- parents are already experiencing time and energy strains so any training/intervention must be practical and not overburdensome. Not to mention that parents are at different degrees of comfortability with technology and teaching and lifelong learning must be differentiated so as to accommodate both technologically adroit and those who are just learning. Cultural and linguistic diversity should also be considered with material and support being provided in multiple languages and across the diversity of family structures and cultural beliefs concerning technology and disability. Lastly, parents need to be informed on the protective measures of privacy and security that relate to their child and ensure that it happens with care and confidentiality.

Policy and advocacy for a Tech-Infused future

With technology coming with more and more integration into our everyday life, the impact it could have in special education is revolutionary. Policies and advocacy efforts that help the development of desirable policies can also enable families to ensure that they are not left out in the digital divide. Some of the areas of policies include the following:

Digital Inclusion and Accessibility

In order to promote the use of technology in parenting in special education, a considerable policy push is required to help facilitate access to lower-cost internet, devices, and accessible computer programs of CWSN families. The barriers of many such families to accessing and exercising the use of digital tools entail the financial and structural drawbacks that worsen the possibilities of these families facing a reliable access to digital tools. The most suitable action would be to offer government-subsidized subsidies or tax credits that would assist such families in obtaining the required technological and services. This funding can also play a big role in closing the digital divide and making learning accessible in the household. Simultaneously, the promotion of universal design principles in education technologies will have to be advocated because the process of adopting universal patterns should support the digital tools that are accessible to users with different abilities by design.

Data Privacy and Ethical Use

With technology a key aspect of parenting and education of CwSN, safeguarding of the delicate information of children and their families is a burning policy issue. The heightened use of the online media opens individuals to the possibility of misuse or breach of personal data. To mitigate this, there is the urgent need to install stringent privacy models that will require secure storage of data, limited access, and definite parental consent requirements prior to any data collection and utilization. All these measures must be universal, in a bid to maintain uniformity and responsibility. In addition to policymaking, advocacy should also be aimed at establishing transparent data handling by Ed-Tech developers, orienting developers on the importance of announcing how they collect, use, and protect data to create trust among families and solidify ethical use of digital means.

Parental Training and Digital Literacy

The only way to enjoy the fruits of technology to the maximum in special education is by ensuring the parents have the relevant expertise to leverage various tech tools. Meeting this policy requirement will entail introducing a tech-literacy education/ training into parent support interventions, which will make digital competency a central part of parenting and education engagement. Integration With Individualized Education Programs. Collaboration between Ed-Tech developers and special educators to create tools that are pedagogically sound, customizable and aligned to each childs goals is a significant action step. In tandem, a policy advocate should advocate the inclusion of technology-based support as part of inclusive education plans, so that every child should experience the benefits of a consistent and tech-enabled learning environment appropriate to the child.

Research and Evaluation

The policy imperative to support technology-mediated parenting in special education is that research on its effectiveness and its long-term effects have to be rigorously and habitually researched. It is important to understand how digital tools can intervene in parenting practices, child development and learning outcomes in order to scale what works. This would be attained by supporting the funding of the longitudinal studies and pilot programs that would analyze different technologies in a wide variety of family situations. The study will provide useful information to set the best practice and implement future interventional programs.

Empowering Parents as Key Stakeholders in Ed-Tech Decisions

This belief is based on the premise that informed parents who are part of the processes and are respected in them are likely to ensure Ed-Tech tools are more sensitive to their childrens individual needs and as a consequence improve education outcomes. Empowerment should also involve provision of support to assist parents in learning how to use these technologies and exploit it to their advantage, like when training is held, workshops or helplines are provided. Above all, it involves providing parents with the leverage to affect the Educational Technology adoption at the level of schools or even the district, or at least to have a say that may be incorporated into the processes of decision-making. It is important to provide parents with authority in Ed-Tech choices as it can lead to equity, where the digital tools are designed in a form inclusive to the needs of various learners that may include children with disabilities and multiple language backgrounds and those who lack technological resources. It also builds confidence and openness; since parents are more aware of how Ed-Tech actually works, and their children data is used, they are more likely to endorse and consider its responsible use.

Strategies for empowering parents in Ed-Tech decisions

Communication must be clear and must entail employing plain language and culturally relevant literature etc. to make information accessible to peoples of all families. Developing the skills of parents by holding workshops on digital literacy and the active use of educational technologies makes them access these courses more actively and confidently. Also, the introduction of consistent feedback model, including surveys, forums or parent Hollywood pictures with teachers, will create a worthy path towards parents airing their grievances or offering suggestions that can benefit the continuous enhancement of Ed-Tech adoption. It is largely based on the realization that they play a key role in determining and facilitating the learning experience of their children and thus they need to have the means, the voice, and the chances to influence the way learning technologies are adopted and implemented.

Fostering a Future of Empowered Families and Thriving Children

The situation of the family is now changing radically Central to this transformation is the increased centrality of technology in the day-to-day lives of people, not just as a set of tools, but as a means of building better relationships, learning more, and providing greater opportunities to all children. Creating a world in which families become more technology-enabled and children live and grow in a healthy way means researching a new method of nurturing, educating and supporting the youngest generation in a digital era. Technology potentially can strengthen the family by establishing improved communication, helping with learning, and the emotional and social growth of the child. In cases where a family has a child with CwSN, assistive technologies provide access to communicating, self-regulation, and academic success that would not have been available in other situations. To achieve tech-enabled families, the parents should be empowered into becoming confident digital stewards. It will entail the provision of information to enable them to use the online environment prudently and purposefully. The parental controls and screen time limits are also essential but introducing to kids healthy tech habits such as digital downtime, joint internet activities and a thinking about what they see online is necessary as well.

The Way Forward for Inclusive, Tech-Enabled Home Interventions

We should realize that, besides being an instrument, technology is a set of thought-problems, institutional problems, interactional problems all of which belong to the jurisdiction of technical reason. The environment of caring is at the risk of being eliminated in this zone since the identity of parents is being reduced to suit a limited dimension. The need to have or develop expertise on parenting is increasingly becoming essential as opposed to adjusting parenting to meet the needs of the child. The current deterministic world has been easily accessible through wide-ranging digitization where individuals of all ages access socialization, entertainment, education, employment, and knowledge that they only dreamed of a few decades ago. As soon as the lockdown started, children and their parents had their daily routines changed rapidly as the activities, which they performed outside their homes (i.e., plays with friends or attendance at school) switched to the screen of the gadgets. With the modernization of modern families, due to the arrival of digital technologies in everyday life, the dynamic between parents and children changed seriously. The main area of interest the researchers should pay attention to is the digital world where childhood, child interactions, and parent-child connections are re-invented. The paper will discuss parent-children relationships in contemporary times. Numerous aspects like the physiological, social, and the psychological environments of the parent and the child interact to influence parent-child interaction.

Children are growing up in the digital world today and have an innate understanding of how to use technology. Living in a technology-rich world, however, needs more than availability - it needs to be crafted with an eye towards supporting attributes of creativity, resilience empathy, and problem-balancing. Tech-enabled learning environs have the potential to tailor learning individually, meet the various requirements, and learning outside the school setting. Gamified applications are able to corroborate motivation and skills training. Speech-to-text, audiobooks, or AIs as tutors may assist children with other forms of learning or disabilities. Notably, technology does not have to stand in place of the human interactions that are vital to child development when applied thoughtfully. To build a society in which family through technology thrives is the task of partnership across sectors.

To guarantee that electronic tools are inclusive, ethical, and development friendly, educators, medical professionals, technologists, and policicians have to collaborate. Parents can be assisted in terms of digital literacy by schools in terms of workshops Technological designers need to remember the children safety and well-being in their design. The enabling factor that can facilitate the implementation of the family-centered innovations is the role of policy makers; they can fund and regulate it. Creating a future where families are enabled by an unprecedented blend of technology and real life is not a matter of screens v. reality, rather, to find ways to integrate technology in life in ways that can empower and enrich lives as well as connect associated individuals and systems.

It is a matter of making sure that no family is left behind in the process of its technology-induced enhanced relationships and see their children grow up to become capable, compassionate and creative adults. Lessons, provisions, and solutions with human values are the way to construct a future where the family can use technology, not to survive but thrive. In the conclusion, the author emphasizes that it is important to develop specific digital parenting programs that will fulfill the specific needs of various parent populations so that they may help families with CwSN. The policies regarding inclusive education must act proactively to promote the inclusion of digital parenting education and recognize it as an essential element of general wellbeing (Kumas and Yildirim, 2024). To outline comprehensive, easily accessible resources and training materials that can address the needs of different levels of development, the collaboration with special education and digital parenting experts is inevitable.

References

1. Apps, J. & Hutton, E. (2024). Parents' and carers' attitudes to the use of digital technology and its role in the care of children with complex needs, British Journal of Occupational Therapy Volume 87, Issue 7 https://journals.sagepub.com/doi/10.1177/03080226241233112
2. Aslam, M., Saeed, S., Hagos, B. & Jamil, B. (2023). Parental/ Caregiver Engagement in Early Learning Systems: Findings from Early Learning Partnership (ELP) COVID-19 Research in Pakistan and Ethiopia, Journal of Research in Childhood Education, 38, https://www.tandfonline.com/doi/full/10.1080/02568543.2023.2222785
3. Bornstein, M. H., & Lansford, J. E. (2010). Parenting. In M. H. Bornstein (Ed.), *Handbook of cultural developmental science* (pp. 259–277). Psychology Press.
4. Corralejo, S. M., Domenech Rodríguez, M. M. (2018). Technology in Parenting Programs: A Systematic Review of Existing Interventions. *J Child Fam Stud* **27**, 2717–2731
5. Darling, J. (2004). Child-centered education and its critics. Paul Chapman Publishing. https://www.academia.edu/125545668/Child_Centred_Education_and_its_Critics_John_Darling_Paul_Chapman_Publishing_1994_pp_viii_119_9_95
6. Flam, R., Ramesh Vasudevan, S., & Coutrim, E. (2024). EdTech to Support Blended Learning in Mozambique. A curated list of EdTech interventions.
7. Flujas-Contreras, J. M., García-Palacios, A., Gómez I. (2019). Technology-based parenting interventions for children's physical and psychological health: a systematic review and meta-analysis. Psychol Med. 49(11):1787-1798. https://pubmed.ncbi.nlm.nih.gov/30977462/
8. Hall, C. M. & Bierman, K.L. (2015). Technology-assisted interventions for parents of young children: emerging practices, current research, and future directions. https://pubmed.ncbi.nlm.nih.gov/27773964/
9. Hansen, A., Broomfield, G., Yap, M. B. (2020). A systematic review of technology-assisted parenting programs for mental health problems in youth aged 0–18 years: Applicability to underserved Australian communities. Aust J Psychol. 71(4):433-462. https://aps.onlinelibrary.wiley.com/doi/am-pdf/10.1111/ajpy.12250
10. Harris, M., Andrews, K., Gonzalez, A., Prime, H., Atkinson, L. (2020). Technology-assisted parenting interventions for families experiencing social disadvantage: a meta-analysis. Prev Sci. 21(5):714-727. https://pubmed.ncbi.nlm.nih.gov/32415543/
11. Kelders, S. M., Kok, R. N., Ossebaard, H. C.,Van Gemert-Pijnen, J. E. (2012). Persuasive system design does matter: a systematic review of adherence to web-based interventions. J Med Internet Res. Nov 14, 2012;14(6)152. https://pubmed.ncbi.nlm.nih.gov/23151820/
12. Kumas, O. A. & Yildirim, A. E. S. (2024). Exploring digital parenting awareness, self-efficacy and attitudes in families with special needs children, British Journal of Educational Technology, 2024;55:2403–2418. wileyonlinelibrary.com/journal/bjet
13. Lusch, R.F. & Nambisan, S. (2015), "Service innovation", MIS Quarterly, Vol. 39 No. 1

14. Mele, C. & Russo-Spena, T. (2024). Agencement of on life and phygital: smart tech–enabled value co-creation practices, Journal of Service Management Vol. 36 No. 2 https://www.emerald.com/insight/content/doi/10.1108/josm-03-2023-0113/full/html
15. See, B. G., Gorard, S., Lu, B., Siddqui, N. & Dong, L. (2020). A systematic review of the impact of technology-mediated parental engagement on student outcomes, Educational Research and Evaluation , An International Journal on Theory and Practice, Volume 26 https://www.tandfonline.com/doi/full/10.1080/13803611.2021.1924791
16. Smedts, G. (2008). Parenting in a technological age. Ethics and Education, 3(2), 121-134. https://doi.org/10.1080/17449640802395992
17. Spencer, C. M., Topham, G. L., King, E. L. (2020). Do online parenting programs create change? A meta-analysis. J Fam Psychol.34(3):364-374.
18. Yap, M. B. (2018). Treatment of paediatric anxiety disorders: what next? Lancet Child Adolesc Health. 2(11):767-769.

TEACHER PREPARATION AND PROFESSIONAL DEVELOPMENT FOR SPECIAL EDUCATION

N. Rajeswari
Research Scholar, Department of Education, Periyar University, Salem

Dr. M. Vakkil
Professor, Department of Education, Periyar University, Salem

Abstract

This paper addresses the teaching components, instructional strategies, evaluation methods, collaboration systems, and other professional development activities geared toward training special education teachers and includes frameworks of evaluation. This discussion is centered on the initial knowledge base training. It comprises the understanding of disability types, relevant legislation such as ADA and IDEA, and the development of IEPs. The teaching strategies include differentiated instruction, the benefit of assistive tools, and the education of relevant and age-appropriate behaviours, including life skills. To provide personalized and fair learning environments, formal and informal assessments, accommodations, and data-driven decision making are key. We must work with general educators, families, and related service professionals to improve student support and strengthen advocacy. Through coaching, peer observation, and the development of practice communities, we see educators engaged in continuous professional growth, which in turn brings them up to speed on the latest in assistive technology, best practices, and regulation changes. We put our professional development resources into the areas of inclusive instruction, trauma-informed teaching, cultural responsiveness, behaviour management, and data literacy. The field is particularly noteworthy due to the challenges it encounters, including insufficient numbers of qualified instructors, poor leadership and pre-service training, limited advancement training, and educator burnout. To address the above challenges, the paper proposes fieldwork, greater interdisciplinary collaboration, and tailoring professional advancement to local needs. To foster long-term educational gains, it is critical to ease barriers to inclusive and equitable education for disabled learners by strengthening educator training and professional development. Educators' training and professional development directly impact the quality of education for learners with impairments.

Keywords: *behaviour management, assistive tools, IEP, professional development, teacher preparation, special education.*

Introduction

The issue of teacher readiness and continuous professional development plays a crucial role in the quality of education we see for students with special needs. We have reported that the requirement for qualified special education teachers who, in turn, can address the wide range of students' needs has greatly grown as we see more inclusive models in our educational systems (Darling-Hammond, 2017). Additionally, it is evident that the elements of teacher preparation and professional development, which are the foundation for instructional success, also play a significant role in the growth of inclusive training settings. To be prepared to teach special education requires a great deal of pre-service training, which in turn gives teachers that they need in terms of specific knowledge in areas like differentiated instruction, IEP's, behavioural interventions, and disability classification (Brownell et al., 2010).

To assist potential educators with applying pedagogical concepts in actual classrooms, effective teaching preparation integrates coursework with field experiences. These kinds of experiences are fundamental for fostering the skills, attitudes, and confidence required to assist students with diverse emotional, physical, and learning challenges. After the initial training phase, professional development is important in sustaining and enhancing a special education teacher's effectiveness. The continuous dissemination of current teaching practices, legislative changes, and innovations in assistive technology supports improvement. High-quality, ongoing, collaborative, and embedded professional development focuses on effective teaching and provides practical approaches that can be easily integrated into classroom instruction (Desimone & Garet, 2015). It enhances educators' professional resilience, decreases burnout, and is vital given the notoriously high turnover within special education. Strikingly, despite its critical value, many educators report feeling underprepared and having constrained access to relevant professional development resources. This gap underscores the urgency of both targeted assistance for special education teachers and a systemic overhaul of teacher training frameworks. To improve educational outcomes and foster the advancement of inclusive education, it is paramount that educators are well-trained, actively supported, and provided with consistent, targeted assistance.

Core Components of Teacher Preparation in Special Education

Foundational Knowledge

Learning base concepts is very important in the training of special education teachers as it provides them with the material to do well with students. For content, we look at what the Individuals with Disabilities Education Act (IDEA) puts forth, which reports 13 different types of disabilities which including emotional disturbance, intellectual disabilities, autism, and specific learning disabilities. Each of these groups has unique features and educational issues that in turn require special instructional and support approaches. In addition to the disability types, future teachers must also be aware of special ed laws. With a good grasp of the legal structures, teachers can step into their roles with confidence and uphold students' rights. Also, a key element of preparation is that teachers do well with IEPs. That is to say that they should know the processes of how to put together an IEP, set out measurable goals, report on student progress, and work with families and multi-disciplinary teams. As per Bateman and Herr (2019) the IEP is a key player in the strategic design for meeting each and every student's diverse needs and also reporting out on service delivery. Also included in the base of what is taught are co-teaching models and inclusive education practices. Co-teaching, which has the teachers plan and teach together, does in fact increase accountability between the two and also increases student engagement. Taken all together, these basic elements see to it that teachers are at once very much in tune with the many different needs of each student, that they are effective in their practices, and also are in compliance with the law.

Instructional Strategies

To teach special education effectively, one must apply flexible, student-centered methods that address a range of learning requirements. The modification of instruction, procedure, learning products, or the environment is called differentiated instruction (Tomlinson, 2014). This principle ensures equitable access for all students, which enables inclusivity and engagement. Students with disabilities are at a great advantage with the availability of adaptive devices and assistive technologies (AT). Al-Azawei et al. (2017) state that screen readers, communication aids, and speech-to-text software, which serve to eliminate learning barriers and foster independence for students, are essential. Moreover, the support of learning environments requires the application of behaviour management frameworks. To explain and address challenging behaviours, functional behavioural assessment (FBA) applies forward-looking approaches such as Positive Behavioural Interventions and Supports (PBIS) at the school level (Sugai & Simonsen, 2012). Finally, teaching students' self-regulation, social skills, and self-control supports their success beyond the school environment. Students taught communication, self-advocacy, emotional regulation, and daily living skills show greater readiness for independence and community participation (Test et al., 2009). The application of these strategies helps develop an inclusive and holistic educational model that is tailored and empowering for all students.

Assessment and Evaluation

The processes of assessment and how we evaluate are very important in special education, as we use them to determine student needs, to target instruction, and to measure academic achievement. We have informal evaluations, which include checklists, observations, and teacher-made assessments that give us day-to-day flexible insight into a student's behaviour and learning (Pierangelo Giuliani, 2012). We also know that progress monitoring is a systematic way to track student performance over time, which in turn is a great way to assess the results of our instructional and intervention methods. We use data in this continuous process to guide any required instructional changes and to see that students are trying to improve toward their IEP goals. (Stecker, Fuchs, Fuchs, 2005). By using objective data to tailor support systems and improve results, we are doing data-driven decision-making. Also, to see to it that we have fair access for students with impairments, we put in place accommodations and modifications in assessments. While modifications change the content or what is expected (for example, simplified test questions), accommodations change how a student interfaces with or responds to the assessment task (for example, extended time or large print) (Thurlow, 2000). By doing this, we see to it that assessments truly represent students' knowledge instead of the effect of their disabilities. Also, out of all of this, we see that successful assessment practices put in place support tailored instruction, foster responsibility, and support student achievement.

Collaboration and Advocacy

Collaboration and advocacy are key skills for special education professionals and are the basis of our all-inclusive student-centered support. We see great value in special ed teachers working with general ed teachers as part of this model. In the everyday practice of what we do, special ed professionals get students with impairments into the common syllabus in inclusive settings by way of co-teaching models, collaborative problem solving, and joint planning (Friend Cook, 2013). Also, we see that consistency, customization of instruction, and the alignment of strategies across settings are what this collaborative approach brings. Also very important is the communication we have with parents and caregivers who are key players in the process. We do this through regular reports, culture-sensitive interaction, and active participation in IEP meetings. What we have found is that strong home-school relationships do, in fact, lead to better student performance, higher family satisfaction, and better goal setting. It is noted that occupational therapists, school psychologists, counsellors, speech language pathologists and other related service providers do very much in tandem with special ed professionals. These experts are very important in the cognitive, emotional, and physical growth of our students. Also, through cooperative team planning, which in turn aligns services with what is put forth in the student's IEP (Dettmer et al., 2013), we see the integration of services. Also, special ed professionals take up the role of advocates for our students; we put forth our students' rights and see to it that their needs and input are put forward in all educational decisions. This in turn, we see to improve equity and inclusion in our school communities.

Professional Development (PD) in Special Education

Continuous Learning

Ongoing professional development (PD) is necessary for special education instructors to stay effective and meet the changing needs of students with impairments. The necessity to stay current with the newest research and evidence-based practices is a significant element of continuous learning. As educational research evolves, new instructional techniques and intervention models are developed to enhance results for students with impairments. Texas and North Carolina professional development opportunities, study groups, and reading relevant literature help to apply scientifically substantiated instructional practices to teaching (Cook & Odom, 2013). Furthermore, knowledge of new assistive technologies is also critical for professional development. Technologies such as speech-generating devices and adaptive learning software transform the ways students with disabilities can access learning. In order to apply the best tools and resources that enhance and help students with disabilities communicate, move, and engage academically, educators have to meet the information requirements (Al-Azawei et al., 2017). Legislative changes such as those about the Individuals with Disabilities Education Act (IDEA), and various state policies affect both classroom practices and students' rights. To remain compliant, proactive, and able to champion for appropriate services, educators must be trained and informed on the latest policy shifts (Yell et al., 2017). By pursuing professional development and lifelong learning, educators refine their practices for all students.

Types of Professional Development (PD) Activities

Professional development (PD) is a wide range of actions that improve teachers' knowledge, ability, and teamwork. We see workshops, seminars and webinars as examples of what we put forward for very targeted education on issues like behaviour management, inclusive practices, and legal updates. Also, it is the case that webinars put out experts and current research in a flexible on on-demand method (Garet et al., 2001). The role of coaching and mentoring is to present small group or individual instruction from experienced teachers or experts. What we see here is that these connections support professional growth, skill development, and reflective practice in particularly for teachers who are just starting out in their careers or who are new to special education (Kretlow Bartholomew, 2010). Also, when coaching is in the classroom setting, which allows for real-time feedback and modelling, better results are seen. Also, we see peer observation and lesson study as examples of collaborative, practice-based PD strategies that have teachers watch each other's teaching methods, give in issue criticism, and together look at teaching practices. Per Lewis et al. (2006), that which does in fact bring about greater reflection, instructional improvement and shared learning. Also, we see communities of practice (CoPs) and teacher learning circles that bring together educators to go over challenges, trade strategies, and look at new ideas. That which puts in place these collaborative environments for continuous inquiry and collective problem solving is what is key to addressing the complex requirements of special education (Wenger, 1998). As a whole, these many PD activities add up to sustainable, meaningful professional development and the betterment of student outcomes.

Focus Areas for Professional Development (PD)

Professional development (PD) in special education should focus on those areas that have a deep influence on student results and instruction practices. One of the major areas of focus is inclusive teaching, which is the teaching of students with disabilities in common schools. PD targets the co-teaching, differentiated instruction, and UDL (Murawski & Swanson, 2001). Another key trauma-informed teaching, which is essential in professional development for many students with impairments due to the trauma they have often undergone. Teachers are trained to understand how trauma can influence learning and behaviour so that they can respond with empathy, consistency, and emotional support (Brunzell, Stokes, & Waters, 2016). From the perspective of today's classrooms, which are often full of students from different cultures and backgrounds, culturally and linguistically diverse teaching is equally important. PD in this area helps equip teachers to embrace the cultural backgrounds of the students, adapt instructions from a linguistic perspective to address and eliminate instruction from biased frameworks (Gay, 2010). This way, the approach advances fair chances to learners from different backgrounds, including English Learners (ELLs). Additionally, relevant professional development (PD) in behaviour and classroom management includes concepts like Positive Behavioural Interventions and Supports (PBIS) and Functional Behaviour Assessment (FBA), which help teachers to build proactive and well-organized learning environments (Sugai & Simonsen, 2012). Lastly, professional development centered on supervising the student progress prepares teachers to edit their lessons and instruction, track IEP goals, and tailor IEP-relevant strategies to student needs and data (Stecker et al., 2005).

Challenges in Teacher Preparation and Professional Development

The professional development (PD) of specialists associated with special education is impacted by a number of components, including a lack of qualified professionals in the industry. An acute shortage of certified special education teachers has serious consequences. The combination of merger compensation, overwhelming workloads, poor career advancement prospects, and lack of proper appreciation (Billingsley, 2004) makes this field unattractive. The existing teachers' caseloads are a result of a lack in the number of teachers, which in turn lowers the quality of instruction. Limited access to professional development is the main culprit for the disparities in the quality of instruction in different regions (Hughes & Kwok, 2007). Due to the multidisciplinary nature of the students' needs, the high expectations from the school administration, coupled with a weak support system, special education teachers face significant emotional and professional exhaustion.

High levels of stress contribute to attrition, which in turn worsens the teacher shortage crisis, negatively affecting both teacher well-being and outcomes for students (McLeskey & Billingsley, 2008). Furthermore, many educators receive inadequate or lopsided training in practice, and this does not prepare them for the demands of today's inclusive and diverse classrooms, which require adaptation to students with different needs and backgrounds, as their pre-service training lacks practical exposure to co-teaching and differentiation (Florian & Linklater, 2010). Addressing these challenges requires more targeted funding, systemic changes focused on professional development, and teacher preparation advancement.

Recommendations for Effective Preparation and Professional Development

Many issues were brought forward that improve the quality of professional development (PD) and teacher preparation in special education. First off, it is very much put forth that pre-service programs, including internships and field experiences, are a must. Pre-service teachers in these settings can develop practical skills and gain confidence in working with disabled students (Smith Ingersoll, 2004). Also, it is noted that we see value in interdisciplinarity, which breaks down the wall between special and general education teachers. This type of training, which improves co-teaching methods, supports inclusive settings, and also sees to it that the approaches to face different needs of students are what we are after (Friend Cook, 2013). Also, PD must not be a one-time thing but an ongoing element of the work environment. In class, long-term coaching and collaborative problem solving, which get new strategies into practice and also give out immediate feedback, which in turn improves retention and application (Desimone, 2009). We also put forward the idea of including professional development reflection, action research, and coaching. Reflection, which is the critical look at what is done in the classroom, and action research, which is the systematic look at what issues come up in the classroom and how to address them, and personal coaching which is that which is tailor-made made which in turn fosters continuous growth (Kraft et al., 2018). Also, to make sure that what is done is relevant and responsive, we must tailor the content to the unique requirements of the students and institution. As per Yoon et al. (2007), what we put out must be tailored to the local context, which in turn improves teacher engagement and brings about large-scale changes in practice. When looked at as a whole, these issues put forth the image of teachers who are knowledgeable, flexible, and reflective, and who are ready to work with disabled students.

Conclusion

Special education teacher preparation and professional development (PD) are what it takes for us to get teachers ready to meet students' needs that come with disabilities. What we see in thorough preparation programs is that they put teachers through a grounding in base-level info, which includes disability classification, special education laws, our Reed tuple going into IEP's individualized education plans, faithful implementation, and in turn this is what gives access to the general curriculum through inclusive approaches. Also very important is what PD does, which is to keep teachers current on new research, assistive technology, and changing legal requirements. We see that workshops, coaching, peer observation, and professional learning communities are what make up high-quality PD, which also promote ongoing development and cooperative problem solving. PD, which is to bring change in teaching methods and improve student outcomes, does best when it is put into the work environment and is custom-made for that setting. Though the benefits are there, issues persist, like a lack of certified special ed teachers, limited access to high-quality PD, which is an issue in underprivileged areas, and teacher burnout. Also, many pre-service programs are not doing enough to prepare teachers for inclusive classrooms, which in turn highlights the need for better training models which put more stress on hands-on learning and interprofessional cooperation. We see that putting in field-based experiences, encouraging interprofessional collaboration, offering continuous and context-specific PD, and supporting coaching and reflection are what are put forth as solutions to improve teacher prep and PD. By putting these into practice, we see teacher effectiveness, retention, and in the end student achievement all improved. In the end, what we have is that the building of an efficient special education workforce depends on investment in extensive, ongoing, and cooperative teacher preparation and PD. By thus investing, we are enabling students with disabilities to reach their full potential.

References

1. Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2017). Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning*, 17(3), 11–24.
2. Bateman, B. D., & Herr, C. M. (2019). *Writing Measurable IEP Goals and Objectives* (3rd ed.). Attainment Company.

3. Billingsley, B. S. (2004). Special education teacher retention and attrition: A critical analysis of the research literature. *Journal of Special Education*, 38(1), 39–55.
4. Brownell, M. T., Sindelar, P. T., Kiely, M. T., & Danielson, L. C. (2010). *Special education teacher quality and preparation: Exposing foundations, constructing a new model*. Exceptional Children, 76(3), 357–377.
5. Brunzell, T., Stokes, H., & Waters, L. (2016). Trauma-informed positive education. *Australian Educational and Developmental Psychologist*, 33(1), 16–32.
6. Cook, B. G., & Odom, S. L. (2013). Evidence-based practices and implementation science in special education. *Exceptional Children*, 79(2), 135–144.
7. Darling-Hammond, L. (2017). *Teacher education around the world: What can we learn from international practice?* European Journal of Teacher Education, 40(3), 291–309.
8. Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, 38(3), 181–199.
9. Desimone, L. M., & Garet, M. S. (2015). *Best practices in teachers' professional development in the United States*. Psychology, Society, & Education, 7(3), 252–263.
10. Dettmer, P., Thurston, L. P., & Dyck, N. J. (2013). *Collaborative Consultation in the Schools: Effective Practices for Students with Learning and Behavior Problems* (4th ed.). Pearson.
11. Florian, L., & Linklater, H. (2010). Preparing teachers for inclusive education: Using inclusive pedagogy to enhance teaching and learning for all. *Cambridge Journal of Education*, 40(4), 369–386.
12. Friend, M., Cook, L., Hurley-Chamberlain, D., & Shamberger, C. (2010). Co-teaching: An illustration of the complexity of collaboration in special education. *Journal of Educational and Psychological Consultation*, 20(1), 9–27.
13. Friend, M., & Cook, L. (2013). *Interactions: Collaboration Skills for School Professionals* (7th ed.). Pearson.
14. Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? *American Educational Research Journal*, 38(4), 915–945.
15. Gay, G. (2010). *Culturally Responsive Teaching: Theory, Research, and Practice* (2nd ed.). Teachers College Press.
16. Hughes, J. N., & Kwok, O. M. (2007). Influence of student-teacher and parent-teacher relationships on lower-achieving readers' engagement and achievement in the primary grades. *Journal of Educational Psychology*, 99(1), 39–51.
17. Kraft, M. A., Blazar, D., & Hogan, D. (2018). The effect of teacher coaching on instruction and achievement: A meta-analysis of the causal evidence. *Review of Educational Research*, 88(4), 547–588.
18. Kretlow, A. G., & Bartholomew, C. C. (2010). Using coaching to improve the fidelity of evidence-based practices. *Teacher Education and Special Education*, 33(4), 279–292.

19. Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? *Educational Researcher*, 35(3), 3–14.
20. McLeskey, J., & Billingsley, B. (2008). *The State of Special Education: Teacher Preparation and Professional Development*. Exceptional Children.
21. Murawski, W. W., & Swanson, H. L. (2001). A meta-analysis of co-teaching research. *Remedial and Special Education*, 22(5), 258–267.
22. Pierangelo, R., & Giuliani, G. A. (2012). *Assessment in Special Education: A Practical Approach* (4th ed.). Pearson.
23. Smith, T. M., & Ingersoll, R. M. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal*, 41(3), 681–714.
24. Stecker, P. M., Fuchs, L. S., & Fuchs, D. (2005). Progress monitoring as essential practice within response to intervention. *Assessment for Effective Intervention*, 30(3), 19–29.
25. Sugai, G., & Simonsen, B. (2012). Positive Behavioral Interventions and Supports: History, defining features, and misconceptions. *Center for PBIS & Center for Positive Behavioral Interventions and Supports*.
26. Test, D. W., Fowler, C. H., Richter, S. M., White, J., & Mazzotti, V. (2009). Evidence-based practices in secondary transition. *Career Development for Exceptional Individuals*, 32(2), 115–128.
27. Thurlow, M. L. (2000). Assessment accommodations for students with disabilities. *National Center on Educational Outcomes*.
28. Tomlinson, C. A. (2014). *The Differentiated Classroom: Responding to the Needs of All Learners* (2nd ed.). ASCD.
29. Turnbull, A. P., Turnbull, R., Erwin, E. J., Soodak, L. C., & Shogren, K. A. (2011). *Families, Professionals, and Exceptionality: Positive Outcomes Through Partnerships and Trust* (6th ed.). Pearson.
30. U.S. Department of Education. (2017). *A Guide to the Individualized Education Program*.
31. Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press.
32. Yell, M. L., Katsiyannis, A., Ennis, R. P., & Losinski, M. (2017). *Special Education and the Law: A Guide for Practitioners* (4th ed.). Pearson.
33. Yoon, K. S., Duncan, T., Lee, S. W.-Y., Scarloss, B., & Shapley, K. (2007). Reviewing the evidence on how teacher professional development affects student achievement. *Issues & Answers Report, REL 2007–No. 033*. U.S. Department of Education.

AN INTELLIGENT COMPUTER-ASSISTED INSTRUCTION SYSTEM FOR CHILDREN WITH SPECIAL NEEDS TO TEACH BODY PARTS

B. Nithya Prabha M.SC.,M.Ed. (Spl.edn(ASD)),
Lecturer(c), NIEPMD, Chennai

Introduction

Autism Spectrum Disorder (ASD) affects social interaction, empathy, communication, and behavior, with symptoms varying widely among individuals. Children with ASD often display unusual speech patterns, poor eye contact, delayed speech, and difficulty maintaining conversations, but can be highly intelligent. They tend to have restricted and obsessive behaviors and need help using language appropriately.

Computer Embedded Instruction integrates various media to enhance learning. Spooner et al. (2006) note that science learning depends on prior knowledge and experiences, which may be limited for adults with ASD.The National Council of Education Research and Training (NCERT) aims to improve academic skills for people with disabilities through innovation. The Indian government's PMGDISHA and NDLM initiatives promote digital literacy in rural areas, including for those with intellectual disabilities.

The Sustainable Development Goal Agenda 2030 aims to reduce inequality and improve health and education. Providing academic skills to disabled children supports these goals. The Indian government has guidelines for creating e-content for children with disabilities, supported by the e-VIDYA initiative for online education.

The RPWD Act protects the rights and dignity of people with disabilities. The National Policy on Education (NPE) focuses on adult education and vocational training for the mentally and physically challenged. Understanding body functions is vital for disabled individuals to protect their health. Research (Smith, Spooner, Wood, 2012) shows technology effectively teaches science to children with ASD in inclusive settings.

Education for Children with Special Needs

The Persons with Disabilities (Equal Opportunities, Protection of Rights, and Full Participation Act, 1995) is crucial for ensuring equal opportunities and full participation for individuals with disabilities in nation-building. The Act addresses various aspects of rehabilitation, including education, employment, vocational training, job reservation, research, manpower development, and creating barrier-free environments.

Special education provides tailored services for children needing special care, focusing on helping them learn and achieve their potential. It involves understanding different disabilities and learning challenges. These programs include therapies such as physiotherapy, speech therapy, and occupational therapy and adapt teaching methods to meet each child's needs. Services are free and available to children up to 21 years old.

In 1966, the Kothari Commission recommended integrating children with disabilities into regular schools, leading to the Scheme of Integrated Education for Disabled Children (IEDC) in 1974. The National Education Policy of 1986 emphasized integrating physically and mentally handicapped children into the general community. The Rehabilitation Council of India Act, 1992, includes special teachers in its definition of 'rehabilitation professionals' and focuses on recognizing courses, setting standards, and registering professionals. Special education schools follow a typical setup but adapt curricula based on assessments. They aim to accommodate students with various disabilities, providing additional educational services like different teaching strategies, technology, and specialized teaching areas.

The Individual Education Plan (IEP) program addresses each child's unique learning issues and sets specific goals. Early assessment ensures timely accommodations, enhancing educational outcomes. Accommodations and modifications in the regular program may include curriculum changes, supplementary aids, equipment, and adapted approaches to facilitate participation.

The Emergence of Education for Children with Autism Spectrum Disorder

The prevalence of ASD is represented as follows

- About 1 in 68 children have been identified with Autism Spectrum Disorder (ASD), according to estimates from Center for Disease Control and Prevention (CDC) and Autism Spectrum Disorder and Developmental Disabilities Monitoring (ADDM) network.
- ASD in almost 5 times more common among boys (1 in 42) than among girls (1 in 189).
- Studies in Asia, Europe, and North America have identified individual with ASD with an average prevalence of about 1%. A study in South Korea reported a prevalence of 2.6% in their country.
- About 1 in 6 children in the United States had developmental disabilities in 20062008, ranging from mild disabilities such as speech and language impairments to serious developmental disabilities, such as intellectual disabilities, cerebral palsy, and Autism Spectrum Disorder.
- Approximately 1 in 500 or 0.20% or more than 2,160,000 people in India are affected by Autism Spectrum Disorder.

Literature Review

Reviewing related literature in CAI for normal school and CAI special education are essential for understanding the existing practices of handling variables in current research, thereby accelerating the proposed research process. To gain current knowledge in the study area and comprehend the research methodology, the authors reviewed related literature.
Morrell (1992) has studied the impact of Computer-Assisted Instruction (CAI) on high school biology students using CAI software in Applesoft BASIC. Results showed CAI was equally effective as traditional teaching. Vernadakis et al. (2005) examined CAI's effectiveness in

preschool education for enhancing cognitive, emotional, linguistic, and literacy skills. The study found CAI significantly improved abstract thinking, planning, vocabulary, and visual-motor coordination. Pilli (2008) assessed the impact of CAI software Frizbi on fourth-grade math achievement. The experimental group using CAI performed better than the traditional teaching group after 15 weeks.

Collins et al. (2008) has investigated CAI's influence on student evaluations and academic performance in a private institution. Results indicated no significant difference in student evaluations, but regular homework completion correlated with better test scores. Ayvaci & Devecioglu (2009) have compared CAI and traditional methods in preschool education. Results showed CAI was more effective for teaching concepts and positively influenced social development. Fong Peng et al. (2009) analyzed CAI in early childhood literature teaching in Malaysia. CAI improved story engagement and understanding, with audio and video elements enhancing interaction. Chang (2010) compared teacher-centered vs. student-centered multimedia CAI on tenth-grade science achievements. Teacher-centered CAI was more effective in promoting science knowledge. Aktaruzzaman & Muhammad (2011) has also compared CAI and traditional methods in educational research. CAI was more efficient and engaging, leading to better student achievement.

Ahiatrogah (2012) conducted a study on CAI's effect on senior high school social studies performance. CAI significantly improved student performance compared to traditional instruction. Cingi (2013) evaluated CAI's impact on education, comparing it with traditional methods. CAI showed positive effects on student performance and engagement. Ahiatrogah (2013) has compared CAI and traditional methods in teaching pre-technical skills. CAI led to better performance compared to traditional methods. Chaudhari (2013) reviewed CAI's effectiveness in biology education, finding it useful as a supplementary tool for overcoming visualization issues in science.

Nandurkar & Bahule (2014) had studied CAI and lecture methods in high school chemistry. Blending CAI with lectures improved learning outcomes.Tolbert Jr. (2015) analyzed CAI's impact using the P.L.A.T.O software, finding neutral performance compared to traditional methods. Nazimuddin (2015) had outlined various CAI modes and their effectiveness in education, concluding that CAI is a globally effective media. Chukwuedozie (2016) investigated CAI's effect on secondary school chemistry students. CAI significantly improved academic achievement and interest.

Verma (2016) has Assessed CAI's impact on Indian students, finding benefits in individualization and interactive learning. Muruganantham et al. (2019) compared CAI and traditional teaching for 10th-grade students, with CAI proving more effective. Bacay & Abagon (2019) had studied CAI's impact on Grade 11 math performance. CAI significantly improved performance compared to traditional methods. Escanilla (2019) had examined CAI's effect on Grade V math achievement. CAI was effective in improving academic performance. Suson & Ermac (2020) assessed CAI's effectiveness in teaching mathematics, finding it more effective than traditional methods.

Computer-Assisted Instruction (CAI) for Children with Special Needs

A study explored using Programmed Instruction to teach mouse pointing skills to preschoolers with developmental disabilities. The three participants, aged 4, underwent a three-stage intervention: moving the mouse, moving the cursor, and clicking specific items. The use of programmed instruction and prompts improved hand-eye coordination, with all participants successfully learning pointing skills [Shimizu & McDonough (2005)]. Rasanen et al. (2009) conducted a study and assessed two computer game-based interventions to improve numeracy skills in 30 children with slow numeracy development. Over three weeks, the experimental group used numeracy games while the control group received verbal instructions. Both groups improved in mathematical skills, suggesting CAI can benefit numeracy development in low-performing children.

Earman Stetter & Tejero Hughes (2011) was investigating CAI for improving reading comprehension in 9th-grade students with learning disabilities, this study involved nine students using a computer-based story mapping program. Post-study surveys indicated that CAI significantly enhanced reading comprehension in students with reading disabilities. Ramdoss et al. (2012) carried out a systematic review on computer-based interventions for daily living skills in children with intellectual disabilities found that 39 out of 42 participants improved their skills through CAI. The review highlighted the effectiveness of using videos, audios, and images in promoting skill generalization.

Falth et al. (2013) had examined the impact of a computerized phonological training program, COMPHOT, on reading skills in 130 students with reading disabilities. After four sessions, students showed improvement in reading skills, with combined interventions proving more effective than individual ones. Ahmet Bilal Ozbek & Alev Girli (2017) had evaluated a tablet-based intervention to improve reading fluency in three students with reading disabilities. The 13-session program involved pre-listening, repeated reading, and feedback. The students enjoyed the tablet-based approach, though the study was limited by its small sample size. Mutlu & Akgun (2017) assessed CAI's effect on approximate number skills in dyscalculic students. Using pretest-posttest methods, the intervention focused on counting, place value, and addition. Results showed significant improvements in the students' number skills and response speed.

CAI for Children with Autism Spectrum Disorder (ASD):

Heimann et al. (1995) used an interactive multimedia program to teach reading and communication skills to 30 children with autism. After 3-4 months, all groups showed significant progress, indicating that interactive CAI can enhance language learning in children with autism. Hetzroni & Tannous (2004) was evaluating a CAI program designed for daily life activities in five children with autism, this study found that CAI improved communication skills, though effects varied among participants. Sathiyaprakash Ramdoss et al. (2011) carried out a systematic review of computer-based interventions for teaching communication skills to children with ASD found that while CAI shows promise, it requires further research to establish it as a fully evidence-based practice.

Khowaja & Salwah Salim (2013) had a review on reading comprehension for children with autism from 2000-2011 found that CAI improved vocabulary and text comprehension. Smith, Spooner, & Wood (2013) were investigating CAI's effectiveness in teaching science to students with ASD, this study found that embedded CAI facilitated the generalization of science terms and concepts. Knight, McKissick, & Saunders (2013) were reviewing 25 studies on technology interventions for children with ASD, the results suggested that technology-based methods are effective, though teachers need to be familiar with these tools.

McKissick et al. (2013) had evaluated CAI's impact on map-reading skills in students with autism. The intervention, which included explicit instruction and CAI, showed promising results in teaching map-reading skills. Knight et al. (2013) was examining systematic instruction and graphic organizers to teach science concepts to students with ASD and intellectual disabilities, this study found that combining these methods can be beneficial. Jenny R. Root et al. (2017) carried out a review of 29 studies confirmed that CAI is an evidence-based practice for teaching academics to students with ASD, supporting its use in literacy, math, science, and social studies. Uma K. & Manikandan K. (2018) had developed an app to improve conversation skills in children with autism. With 10 participants, the app facilitated communication, demonstrating the potential of technology-based interventions for enhancing communication skills.

By reviewing all the methods and techniques in the literature indicated that each method has its own merits and demerits. To overcome the demerits an innovative intelligent computer assisted instruction technique is developed to teach the body parts for the ASD kids in this research work

Use of Computers in Teaching and Learning

Computers have revolutionized the teaching profession, providing a powerful tool for students to learn new skills. Teachers use computers for recording grades, calculating averages, managing attendance, and accessing student performance data in both online and offline programs. They also facilitate easier delivery of instructions and help engage students, improving their understanding of concepts.

In educational institutions like schools, colleges, and universities, computers enhance the learning process. Teachers use audio-visual techniques to deliver lessons, making education more interactive and effective.

Computer-Assisted Instruction (CAI)

Computer-Assisted Instruction (CAI) is an interactive method where computers provide instructions and monitor learning. CAI utilizes text, graphics, animation, sound, and video to improve teaching and learning quality. It benefits all students, including those with disabilities, by facilitating instruction and offering a personalized learning environment.

Aspects of CAI

- Text or multimedia content
- Multiple-choice questions

- Immediate feedback
- Notes on incorrect responses
- Summarizes students' performance
- Exercises for practice
- Worksheets and tests

CAI on Academic Learning of Children with ASD

This proposed research work focusing on the visual picture presentations of the body parts to facilitate learning for ASD children. The main objectives of this proposed study are to

- Examine the effect of computer-embedded instruction on learning body part functions for ASD children.
- Compare the impact between experimental and control groups.

The proposed CAI technique Enhances learning, engagement, and provides visual support for ASD children. This also expected to yield to certain adverse effects such as limited skills reduce effectiveness and overuse can lead to addiction. But this technology provides few significant outcomes for instance improves understanding of body parts and functions using technology, promoting self-care and communication. Also, assists teachers in developing computer-embedded instruction for ASD children.

The hypothesis of this proposed study is defined as follows

- There is no significant difference between pretest and post-test on achievement of learning the functions of body parts among experimental group through computer embedded instruction.
- There is no significant difference between pretest and post-test on achievement of learning the function of body parts among control group through computer embedded instruction.
- There is no significant difference on pretest and posttest between the experimental and the control group.
- There is no significant difference between the pretest and post-test on achievement of learning the functions of body parts through computer embedded instruction with respect to age.

The delimitations of this proposed study

- The investigator conducted this two group experimental study only with the limited samples. The samples for the study were collected from the special schools of National Institute for Empowerment of Persons with Multiple Disabilities, Chennai.
- This experimental study was conducted only among the children with autism in the age group from 14 to 18 years.
- The study was focused only on functions of body parts among children with Autism Spectrum Disorder Spectrum

Methodology

The methodology of the proposed research work includes population, sample and sampling technique, research design, development of the tool, data collection procedure, intervention, processing of data and plan for data analysis. This study has been conducted at NIEPMD to examine the effect of using computer embedded instruction in learning functions of body parts for children with autism spectrum disorder. The samples were selected at NIEPMD model school and from Department of Special Education Services.

Sample Selection and Description

The sample consist of 8 children with Autism Spectrum Disorder and Intellectual disability as additional disabilities. The samples were selected based on purposive sampling technique. The groups of the children ranges from 14 to 18 years of age were taken from the secondary, pre-vocational and transitional units at NIEPMD model school and Department of Special Education services were selected. The assessment and diagnosis of children with ASD was done by Rehabilitation professionals and document was maintained by the institute. The demographic data of the collected samples were grouped as experimental group and the control group.

Experimental Group

The Table 1 shows the experimental group of disabled children considered for the proposed research work. The characteristics of the experimental group is described as follows.

Subject 1: A 15-year-old male with autism, diagnosed at age 4. He has poor eye contact and concentration but can follow instructions, make phrases, and express needs verbally. He enjoys computer-based learning, painting, and drawing, and is enrolled in a computer course. He is in 10th grade at a government school in Kovalam.

Subject 2: A 15-year-old male with autism and intellectual disability, diagnosed at age 2. He has poor eye contact and speech limited to single words but excels in artistic skills and can copy drawings. He exhibits echolalia but is actively engaged in computer-based classes.

Subject 3: A 14-year-old male with mild autism and intellectual disability, diagnosed at age 5. He has good memory, can read, write, and respond to questions in English. He participates well in computer-based classes and can summarize and answer questions on the topics covered.

Subject 4: A 16-year-old male with autism and intellectual disability, diagnosed at age 5. He has poor eye contact and verbal communication but is good at imitating drawings and logos. He exhibits echolalia but prefers visual learning through computer-based activities.

Table 1 The Experimental Group of the proposed research work

S.No	Name	Age	Disability diagnosis	Category	Gender
1	Subject 1	15	4	ASD	M
2	Subject 2	15	2	ASD +ID	M
3	Subject 3	14	5	ASD +ID	M
4	Subject 4	16	5	ASD + ID	M

Control Group

The Table 2 shows the control group of disabled children considered for the proposed research work. The characteristics of the control group is described as follows.

Table 2 The Control Group of the proposed research work

S.No	Name	Age	Disability diagnosis	Category	Gender
1	Subject 5	18	4	ASD	F
2	Subject 6	14	5	ASD	M
3	Subject 7	17	5	ASD+ ID	M
4	Subject 8	16	3	ASD	M

Subject 5: An 18-year-old female with autism and ADHD, diagnosed at age 4. She is nonverbal but hums songs and enjoys music and watching television. She has sensory issues and likes watching rhymes on the computer.
Subject 6: A 14-year-old male with autism and hearing issues, diagnosed at age 5. He is a visual learner and responds well to teacher instructions. He has good memory skills with continuous training but may forget skills after health-related interruptions.
Subject 7: A 17-year-old male with autism and ADHD, diagnosed at age 5. He needs monitoring to complete activities and exhibits behavioral issues like hand-flapping and head-banging. He has sensory issues and responds to teacher instructions, often holding materials like threads for sensory input.
Subject 8: A 16-year-old male with autism, diagnosed at age 3. He loves music and has a habit of smelling objects. He learns well through rhymes and can perform basic activities with his mother's help. He recites slogans, mantras, and rhymes.

Inclusion and Exclusion Criteria

Children meeting ICD-10 criteria for autism spectrum disorder and intellectual disability attending special schools with mild to moderate disability were included.

Children with serious physical or mental problems, chronic neurological conditions such as cerebral palsy or epilepsy, were excluded.

Quasi-Experimental Design

The researcher employed a quasi-experimental design to estimate the causal impact of an intervention on a target population without random assignment. This design aims to establish a cause-and-effect relationship between independent and dependent variables. Initially, the researcher identifies the variables and divides them into two groups: one receiving treatment (experimental group) and one not (control group). The quasi-experimental design used is the non-equivalent group design, which is effective because it allows for pre-post testing. A pretest is conducted before the intervention, and a post test is done after its completion, the conceptual framework was structured accordingly.

In this nonequivalent group design, only the experimental group undergoes the intervention:
Experimental group: Pre-test → Intervention (X) → Post-test
Control group: Pre-test → No intervention → Post-test

Conceptual Framework

The conceptual framework and the design of the proposed research work is shown in Figure 2. The researcher followed the two group experimental design where the sample size is 8. The samples were selected on purposive sampling technique. The researcher had divided the samples into two group, one as experimental group and another as control group. In experimental group 4 people with moderate and mild disability of ASD with intellectual disability were selected and have given intervention with the help of computer embedded instructions along with traditional way of classroom teaching. Whereas in control group the children with ASD and intellectual disability were grouped and given only traditional method of teaching. Both the groups were given pretest to check their level of understanding on the content. The researcher had noted down the score. Then they were provided with intervention using computer consists of packages. After completing intervention, they were given posttest.

Tools and Variables: The researcher had utilized self-made achievement test for children with autism spectrum disorder. The syllabus or lessons was taken from the syllabus of 6^{th} to 8^{th} standard Tamilnadu State Board Curriculum.

Dependent variable: learning functions of body parts

Independent variable: computer embedded instructions

Procedure

Identification of Sample: Eight children with ASD and intellectual disabilities were divided into experimental and control groups. The experimental group consisted of children with mild/moderate disabilities who have verbal communication and are in inclusive education, while the control group included children from the NIEPMD model school.

Tool Development and Implementation: The study aimed to develop learning skills on body part functions using computer-embedded instruction, involving:

- Pretest and posttest achievement tools.
- An intervention package with PowerPoint presentations, videos, and pictures.
- Application of learning skills.

Informed Consent: Parents received informed consent forms detailing the study, investigator, confidentiality clauses, and purpose. Consent was obtained for children aged 14-18 years.

Pre-test: Personal details were collected, and pretests were administered to both groups. Data were saved in an Excel sheet for analysis.

Intervention: The intervention covered the circulatory, respiratory, digestive, and excretory systems. Content was delivered through computer instruction, one topic at a time.

Instrumentation: A test evaluated children's understanding of the content. It included 20 questions (5 per domain), scored 1 mark for correct answers and 0 for wrong answers. Using VBScript coding, the test ensured children could not proceed without answering correctly, and no marks were given for reattempts (Appendix II).

Reliability of Achievement Test Tool: Test items were organized by body part functions to assess reliability. Three NIEPMD model school students were independently assessed, showing a high positive correlation among evaluations. Test-retest methods determined tool consistency.

Validity of Achievement Test Tool: Content validity was ensured by circulating the tool among 10 rehabilitation professionals at NIEPMD. Feedback was recorded, discussed with a guide, and incorporated as approved.

Pilot Study: A pilot study with NIEPMD special education students (ages 14-18 years) tested the tool's feasibility. Twenty multiple-choice questions on body part functions were given, showing age and level appropriateness. The study assessed the tool's comprehensibility and relevance to the research hypothesis.

Data Collection Procedure: The researcher and teachers collected pretest and posttest scores using a two-group experimental method. Testing conditions were maintained for analysis. Consent was obtained from children and parents, who were informed in their native language. The intervention, lasting 30 sessions of 45 minutes each, used computer-embedded and traditional teaching methods for the experimental group, while the control group used usual strategies. Sessions were conducted in a distraction-free classroom. Evaluations were done every 15 days, with a posttest after the intervention. Data were collected and recorded.

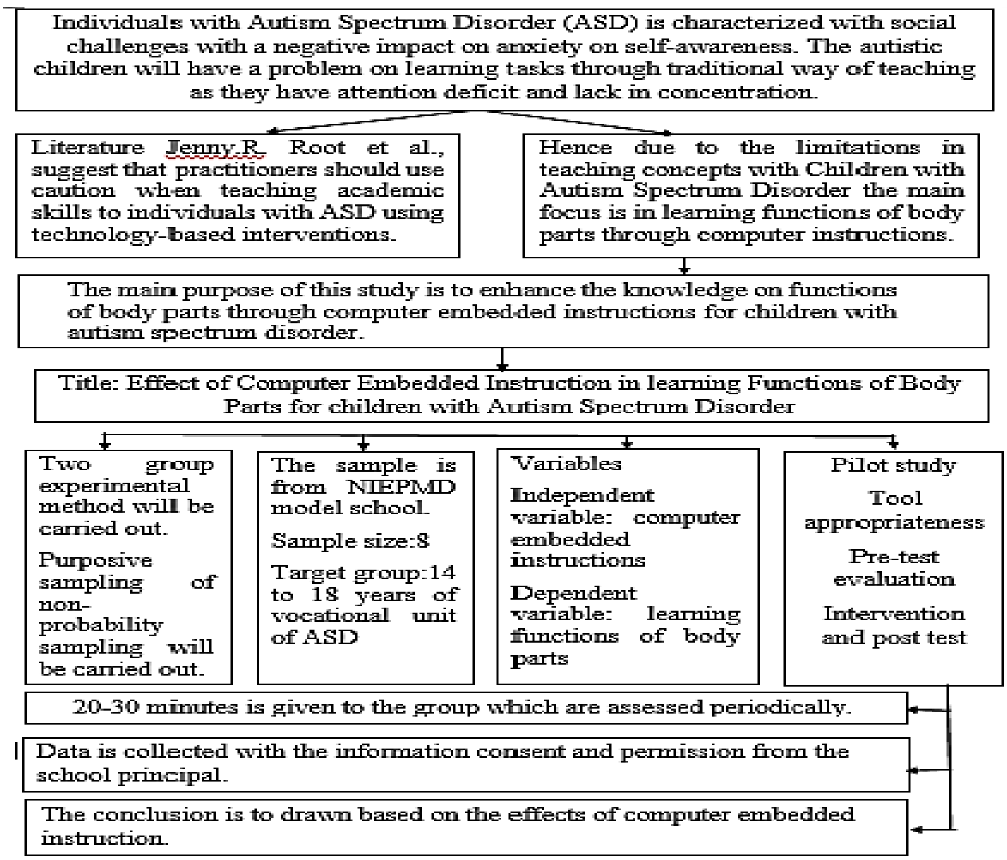


Figure 2. Conceptual Frame work of the Proposed Research

Intervention by CAI system

The main objective of the intervention with ASD children using CAI system is to understand body functions (circulatory, respiratory, digestive, and excretory systems). For this intervention procedure classroom environment has been set-up and conducted CAI based intervention as shown in Figure 3. Before carrying our evaluation process, this intervention shown in Figure 4 and Figure 5 has been carried out for Experimental and Control group as described as follows

Experimental Group:

- Intervention via computer-based instruction.
- Individual sessions.
- Pretest conducted to assess prior knowledge; scores recorded in an Excel sheet.
- Learning materials included image slides, content slides, 3D video slides, and voice notes in the regional language.
- Training on organ identification, followed by content explanation and 3D demonstrations.
- Each domain intervention lasted about 2 weeks.

Control Group:

- Traditional special education teaching methods.
- Activities included grouping, sorting, and naming body parts using flashcards.
- Task analysis for understanding body functions.
- Explanation through charts.

Evaluation: The CAI system based evaluation is shown in Figure 6.

- Post test administered individually to both groups.
- Post test data recorded in Excel for analysis.

Data Analysis:

The collected data from the experimental study were organized into a table in Excel and analyzed using IBM SPSS software version 2.0. Descriptive statistical analysis was conducted, including calculations of mean and standard deviation for pre-test and post-test scores. These scores were compared to draw conclusions. Graphical tools like bar charts and histograms were used to present the findings effectively.

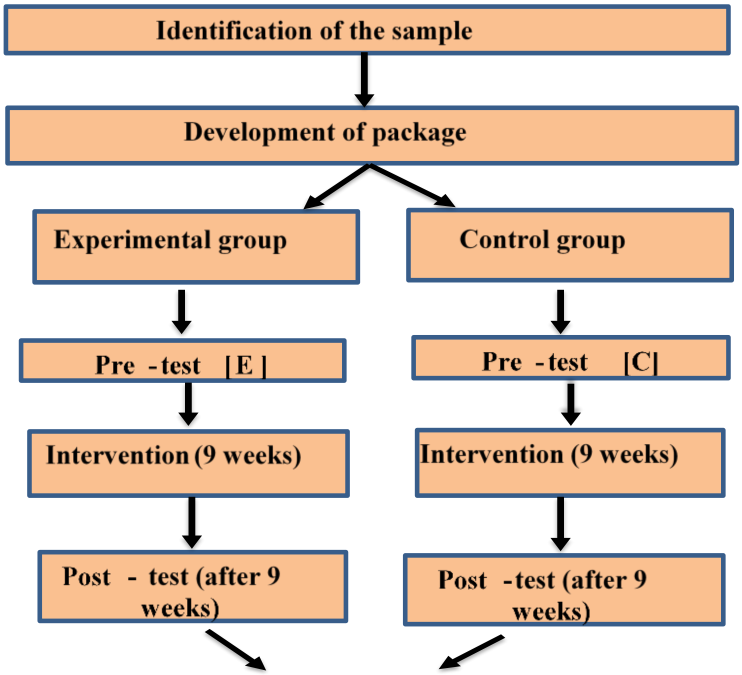


Figure 3. Flow Diagram of ASD children intervention using CAI System

Control Group:

- Traditional special education teaching methods.
- Activities included grouping, sorting, and naming body parts using flashcards.
- Task analysis for understanding body functions.
- Explanation through charts.

Evaluation: The CAI system based evaluation is shown in Figure 6.

- Post test administered individually to both groups.
- Post test data recorded in Excel for analysis.

Data Analysis:

The collected data from the experimental study were organized into a table in Excel and analyzed using IBM SPSS software version 2.0. Descriptive statistical analysis was conducted, including calculations of mean and standard deviation for pre-test and post-test scores. These scores were compared to draw conclusions. Graphical tools like bar charts and histograms were used to present the findings effectively.

Result and Discussion

This section presents a detailed analysis of the empirical findings from the investigation. The collected data were coded, tabulated, and analyzed using statistical methods. The obtained results are organized in four categories as follows

- Effectiveness of Computer embedded instruction in learning functions of body parts among experimental group for children with autism spectrum disorder.

- Effectiveness of learning functions of body parts among control group for children with Autism Spectrum disorder.
- Effectiveness of learning functions of body parts through computer embedded instructions on experimental group and control group among children with ASD.
- Effectiveness of learning functions of body parts among children with ASD with respect to age.

Effectiveness of Computer embedded instruction in learning functions of body parts among experimental group for children with ASD

Computer-embedded instruction, utilizing PowerPoint presentations, audio, videos, and pictorial content, proved effective in engaging autistic children. There is no significant difference between pretest and post-test results for learning body part functions in the experimental group using computer-embedded instruction.

Table 3. Mean, Standard Deviation, t-value of Pretest and Posttest scores of Experimental group

	N	Mean	S.D	df	't' value	Sig
Pretest	4	4.25	1.708	6	4.802	0.00
Posttest	4	10.75	2.754	6		

The Figure 7 and Table 3 represents Mean, Standard Deviation, t-value of pretest and posttest performance of experimental group among children with autism spectrum disorder. It was inferred from the table that the overall pretest mean of experimental group is 4.25 and the posttest mean of experimental group is 10.75. It indicates t value is 4.802 and p value is 0.00 which is significant at 1% level. Therefore, the null hypothesis stated that there is no significant difference between the effectiveness of computer embedded instruction in learning functions of body parts among children with ASD is rejected. Hence it is concluded that computer embedded instruction enhance the achievement in learning functions of body parts among children with Autism Spectrum Disorder.

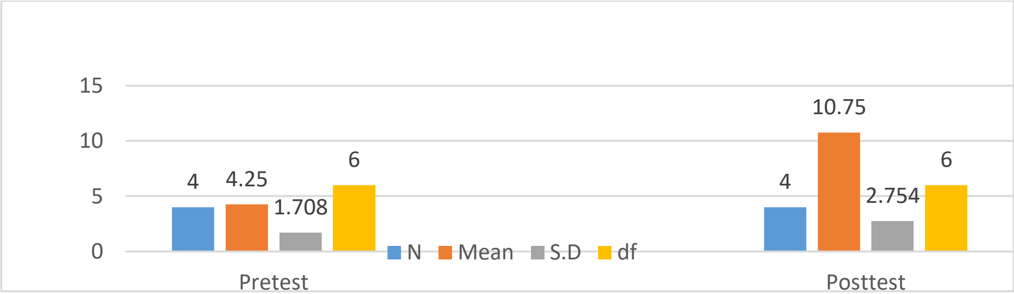


Figure 7. The pretest and posttest means, number of participants, and standard deviations for the experimental group's learning of body part functions in children with ASD

Effectiveness of learning functions of body parts among control group for children with ASD

There is no significant difference between pretest and post-test on achievement of learning the function of body parts among control group through computer embedded instruction.

Table 4. Displays the Mean, Standard Deviation, t-value of Pretest and Posttest scores of control group

Domain	N	Mean	S.D	Df	't' value	sig
Pretest	4	1.25	0.500	3.511	4.802	0.01
Posttest	4	3.75	0.957	3.715		

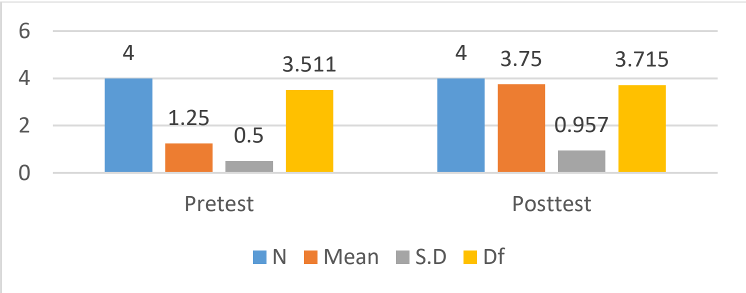


Figure 8. The mean scores, number of participants, and standard deviation for the pretest and posttest in the control group's regarding the learning of body part functions among children with ASD

Figure 8 and Table 4 presents the mean, standard deviation, and t-values for the pretest and posttest performances of children with autism spectrum disorder. The data shows that the control group's mean score increased from 1.25 in the pretest to 3.75 in the posttest. The t-values are 3.372 for the pretest and 4.802 for the posttest, with a p-value of 0.01, indicating statistical significance at the 5% level. As a result, the null hypothesis—that there is no significant difference in the effectiveness of learning body part functions among children with ASD—is rejected. Therefore, it is concluded that there is a significant improvement in learning body part functions within the control group of children with Autism Spectrum Disorder.

Effectiveness of learning functions of body parts through computer embedded instructions on experimental group and control group among children with ASD.

There is no significant difference on pretest and posttest between the experimental and the control group.

Table 5. The mean, standard deviation value of posttest performance of experimental and control group

Domain	Group	N	Mean	S.D	df	't'value	Sig
Posttest	g1 (Experimental group)	4	10.75	2.754	6	4.802	0.00
	g2 (control group)	4	3.75	0.957	3.715		

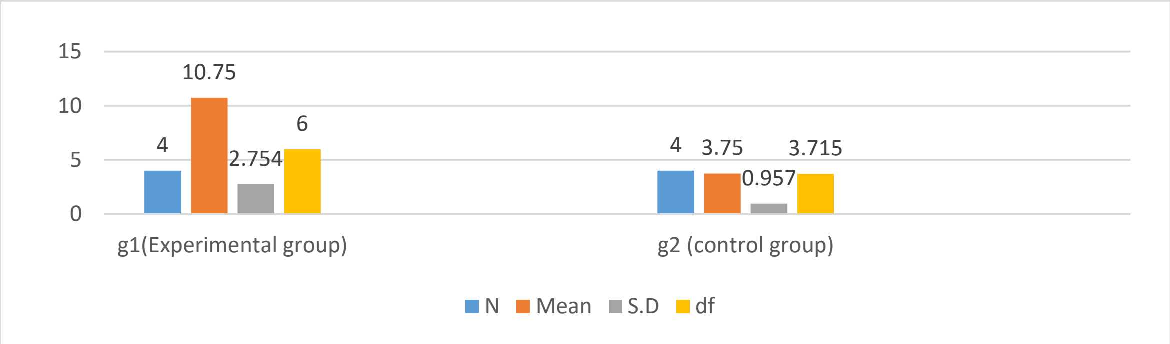


Figure 9. The mean, Number of Participants and Standard Deviation comparison of experimental group and control group on learning functions of body parts among children with ASD

Figure 9 and Table 5 represents the mean, standard deviation, and t-values for the posttest performances of children with Autism Spectrum Disorder in both the experimental and control groups. The data indicates that the mean posttest score for the experimental group is 10.75, while the mean for the control group is 3.75. The t-values are 4.802 for both groups, with a p-value of 0.00 for the experimental group and 0.010 for the control group, both significant at the 1% level. Thus, the null hypothesis—that there is no significant difference in the effectiveness of learning body part functions between computer-embedded instructions and traditional methods in the control group—is rejected. Consequently, it is concluded that the experimental group, which received computer-embedded instruction, shows a significant improvement in learning body part functions compared to the control group among children with Autism Spectrum Disorder.

Effectiveness of learning functions of body parts among children with ASD with respect to age

There is no significant difference between the pretest and post-test on achievement of learning the functions of body parts through computer embedded instruction with respect to age.

Table 6. Mean, Standard Deviation, t-value of pretest and posttest performance on learning functions of body parts among autism spectrum disorder with respect to age

Domain	Age	N	Mean	S.D	df	't' value	Sig
Pretest	above 16	4	1.50	0.577	6	-2.236	0.09
	below 16	4	4.00	2.160	3.426		
Posttest	Above 16	4	4.75	2.363	6	-2.020	
	below 16	4	9.75	4.349	4.629		

Figure 10 and Table 6 reveal the mean scores for children with Autism Spectrum Disorder, categorized by those aged 16 and above versus those below 16, concerning the learning of body part functions. The pretest mean scores are 1.50 for children below 16 and

4.00 for those aged 16 and above, while the posttest mean scores are 4.75 and 9.75, respectively. The standard deviations for the pretest are 0.577 and 2.160, and for the posttest, they are 2.363 and 4.349. The t-values are -2.236 for the pretest and -2.020 for the posttest. With a p-value of 0.09, which is not significant at the 5% level, the null hypothesis is accepted. Thus, it is concluded that there is no significant difference in the learning of body part functions based on age among children with Autism Spectrum Disorder.

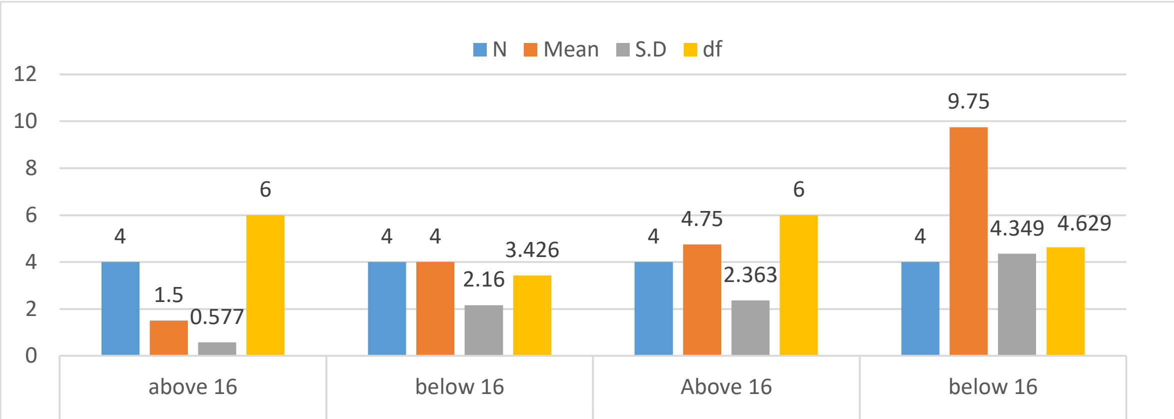


Figure 10. Mean, Partcipants and Standard deviation performance of learning functions of body parts in Children with Autism Spectrum Disorder with reference to age

Key Findings of the Proposed Research

The key findings of this study are summarized as follows:

Effectiveness of Computer-Embedded Instruction: The study found that computer-embedded instruction significantly enhanced learning skills related to body parts functions among children with Autism Spectrum Disorder (ASD). There was a notable improvement in posttest scores for the experimental group, which received intervention in four domains: the circulatory, respiratory, digestive, and excretory systems.

Control Group Improvement: The control group, which received traditional instruction, showed minimal improvement in learning skills compared to the experimental group.

Age and Effectiveness: The intervention proved effective across different ages, with no significant differences in learning outcomes based on age. Performance improvements were consistent among children of varying ages.

Comparison of Groups: The experimental group, which received computer-embedded instruction, outperformed the control group in posttest scores. This suggests that computer-embedded instruction is more effective than traditional methods for children with ASD.

Overall Impact: The study concludes that computer-embedded instruction significantly enhances academic achievement in learning functions of body parts for children with ASD.

Statistical results indicate that computer-embedded instructions significantly improved the experimental group's performance in learning body part functions compared to pretest scores. This intervention, covering the circulatory, respiratory, digestive, and excretory systems, demonstrated effectiveness, aligning with Smith (2013), who found that computer-assisted instruction (CAI) enhanced science learning for students with Autism Spectrum Disorder. Similarly, Ozbek et al. (2017) reported that tablet-based interventions improved reading fluency, supporting the effectiveness of CAI.

In contrast, the control group, which received traditional instruction and online teaching due to COVID-19, showed less improvement in learning body functions. This finding concurs with Md. Aktaruzzaman's (2011) study, which demonstrated CAI's superiority over traditional methods.

Comparing posttest results, the experimental group outperformed the control group in learning body part functions, reflecting significant gains in all domains. This is consistent with Susan (2020), who reported CAI's greater effectiveness in mathematics compared to traditional teaching methods.

However, there was no significant difference in learning outcomes based on age, with a p-value of 0.278. This minimal variation supports the null hypothesis that age does not affect the effectiveness of CAI. This is in line with literature showing CAI's overall positive impact on learning processes.

Conclusion

Computer-embedded instruction is a crucial strategy for enhancing academic achievement in children with Autism Spectrum Disorder (ASD) within today's educational framework. This study offers valuable insights and strategies for improving academic performance in ASD students, leading to more successful classroom learning. The intervention using computer-based methods for the experimental group yielded notably better outcomes compared to the control group. The findings highlight the significant role of computer-embedded instruction in developing learning skills for children with ASD, suggesting its potential to significantly contribute to their holistic development.

This research will involve larger sample sizes to enhance generalizability and can explore varying age groups and different curriculum subjects to improve outcomes in inclusive settings. The developed techniques will be combining computer-embedded instruction with traditional teaching methods could yield comprehensive results. It has valuable scope for online teaching during the pandemic, enhancing learning effectiveness. The researchers will also explore computer-embedded instruction for home-based interventions, especially for children with ADHD.

References

1. Ayvacı, H. S., & Devecioğlu, Y. (2010). *Computer-assisted instruction to teach concepts in pre-school education. Procedia - Social and Behavioral Sciences, 2(2), 2083–2087.* doi:10.1016/j.sbspro.2010.03.285 . Retrieved at https://www.academia.edu/5135701
2. Ahiatrogah, P. D., Madjoub, M. B., & Bervell, B. (2013). *Effect of Computer Assisted Instruction on the Achievement of Basic School Students in Pre-Technical Skills. Academic Journal of Interdisciplinary Studies.* doi:10.5901/ajis.2013.v2n1p77 . Available at https://sci-hub.se/10.5901/ajis.2013.v2n1p77

3. Md. Aktaruzzaman , Dr. Khushi Muhammad (2011). *A COMPARISON OF TRADITIONAL METHOD AND COMPUTER AIDED INSTRUCTION ON STUDENTS ACHIEVEMENT IN EDUCATIONAL RESEARCH. Academic Research International,1(3).* Retrieved at https://sci-hub.do/http://www.savap.org.pk/journals/ARInt./Vol.1(3)/2011(1.3-26).pdf
4. Ahmet Bilal Ozbek, Alev Girli(2017). *The Effectiveness of a Tablet Computer-aided Interevntion Program for Improving Reading Fluency. Universal Journal of Educational Research 5(5), 757- 764.* DOI: 10.13189/ujer.2017.050508. Retrieved at https://www.academia.edu/43862054
5. Bridget Chimaobi Chukwuedozie(2016). *EFFECT OF COMPUTER ASSISTED INSTRUCTION ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND INTEREST IN CHEMISTRY.* Retrieved at https://www.academia.edu/40489216/
6. Chew Fong Peng, The Ying Wah, Zahari Ishak (). *Computer-Assisted Instruction in Teaching Early Childhood Literature.6(9).* Available at https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.588.4896&rep=rep1&type=pdf
7. Chun-Yen Chang(2002). *The Impact of Different Forms of Multimedia CAI on Students' Science Achievement. Innovations in Education and Teaching International,39(4),280-288.* DOI: 10.1080/13558000210161052.. Retrieved at https://www.tandfonline.com/doi/abs/10.1080/13558000210161052
8. Cingi, C. C. (2013). *Computer Aided Education. Procedia - Social and Behavioral Sciences, 103, 220–229.* doi:10.1016/j.sbspro.2013.10.329. Retrieved at https://sci-hub.do/https://www.sciencedirect.com/science/article/pii/S1877042813037749 David Collins, Alan Deck, Myra McCrickard (2008). *Computer Aided Instruction: A Study Of Student Evaluation And Academic Performance. Journal of College Teaching & Learning, 5(11).*Retrieved at https://www.academia.edu/35283704
9. Ernest Tolbert Jr. (2015). *The Impact of Computer-Aided Instruction on Student Achievement. Education Dissertations and projects,127.* Retrieved at https://sci-hub.do/The+Impact+of+Computer-Aided+Instruction+on+student+Achievement
10. Elizabeth V. Bacay, Rosana M. Abagon (2019). *COMPUTER-ASSISTED INSTRUCTION IN TEACHING MATHEMATICS.OCER International Multidisciplinary Research Journal.* Retrieved at https://www.academia.edu/41296342
11. Heimann, M., Nelson, K. E., Tjus, T., & Gillberg, C. (1995). *Increasing reading and communication skills in children with autism through an interactive multimedia computer program. Journal of Autism and Developmental Disorders, 25(5), 459–480.* doi:10.1007/bf02178294. Retrieved at https://www.academia.edu/18244454/Increasing_reading_and_communication_skills_in_children_with_autism_through_an_interactive_multimedia_computer_program
12. Hetzroni, O. E., & Tannous, J. (2004). *Effects of a Computer-Based Intervention Program on the Communicative Functions of Children with Autism. Journal of Autism and Developmental Disorders, 34(2), 95–113.* doi:10.1023/b:jadd.0000022602.40506.bf .

Retrieved at https://sci-hub.do/https://link.springer.com/article/10.1023/B:JADD.0000022602.40506.bf

13. Khowaja, K., & Salim, S. S. (2013). *A systematic review of strategies and computer-based intervention (CBI) for reading comprehension of children with autism. Research in Autism Spectrum Disorders, 7(9), 1111–1121.* doi:10.1016/j.rasd.2013.05.009 . Retrieved at https://www.academia.edu/25431856
14. Kister Quin e. Escanilla (2019). *THE EFFCET OF COMPUTER ASSISTED INSTRUCTION TO MATHEMATICS ACHIEVEMNET OF GRADE V STUDENTS.* Retrieved at https://www.academia.edu/40187927
15. Knight, V., McKissick, B. R., & Saunders, A. (2013). *A Review of Technology-Based Interventions to Teach Academic Skills to Students with Autism Spectrum Disorder. Journal of Autism and Developmental Disorders, 43(11), 2628–2648.* doi:10.1007/s10803-013-1814-y . Available at https://sci-hub.se/10.1007/s10803-013-1814-y
16. Knight, V. F., Spooner, F., Browder, D. M., Smith, B. R., & Wood, C. L. (2013*). Using Systematic Instruction and Graphic Organizers to Teach Science Concepts to Students With Autism Spectrum Disorders and Intellectual Disability. Focus on Autism and Other Developmental Disabilities, 28(2), 115–126.* doi:10.1177/1088357612475301. Retrieved at https://sci-hub.se/10.1177/1088357612475301
17. Kamran Khowaja, Siti Salwah Salim (2013). *A systematic review of strategies and computer based intervention(CBI) for reading comprehension of children with autism*.7(9), DOI:10.1016/j.rasd.2013.05.009. Retrieved at https://www.academia.edu/37784579
18. Linda Falth, Stefan Gustafson, Tomas Tjus, Mikael Heimann and Idor Svensson(2013). *Computer- assisted Interevntion Targetting Reading Skills of Children with Reading Disabilities-A Longitudinal Study.37-53.*DOI: 10.1002/dys.1450. Retrieved at https://www.academia.edu/18244439
19. Dr.D.Muruganantham, V. Titus John Bosco (2019). *Effectiveness of Computer Assisted Instruction(Cai) Package On Learning Matrics Among Xth Standard Students In Tuticorin Educational District. International educational & Research Journal,5(1).* Retrieved at https://www.academia.edu/45299981
20. Maria Earman Stetter , Marie Tejero Hughes(2011). *Computer Assisted Instruction to Promote Comprehension in Students with Learning Disabilities. International Journal of Special Education,26(1),88-101.*Retrieved at https://www.academia.edu/2314915
21. McKissick, B. R., Spooner, F., Wood, C. L., & Diegelmann, K. M. (2013). *Effects of computer-assisted explicit instruction on map-reading skills for students with autism. Research in Autism Spectrum Disorders, 7(12), 1653–1662.* doi:10.1016/j.rasd.2013.09.013 Retrieved at https://sci-hub.do/https://www.sciencedirect.com/science/article/pii/S1750946713001840
22. SK. Nazimuddin (2015). *Computer Assisted Instruction(CAI): A New Approach in the Field of Education. International Journal of Scientific Engineering and Research.3(7), 185-188.* Retrieved at https://sci-hub.do/http://lcwu.edu.pk/ocd/cfiles/Professional%20 Studies/CC%20/B.Ed.-%20104/computerassistedinstruction.pdf

23. Patricia D. Morrell (1992). *The Effects of Computer Assisted Instruction on Student Achievement in High School Biology.* 92(4). Retrieved at https://www.academia.edu/2067088
24. Paul Dela Ahiatrogah, Brandford Bervell, Augustine Yakubu (2012). *Integration of Technology in Teaching Senior High School Social Studies: The Computer Assisted Instruction Effect on Students' Performance. 2(12).* Retrieved at https://ijrcm.org.in/article_info.php?article_id=2601
25. Pinkal Chaudhari (2013). *Computer Assisted Instruction (CAI): Development of instructional Strategy for Biology Teaching. Educationia Confab 2(1), 106-116.*Retrieved at
26. https://www.academia.edu/3318237
27. Ramdoss, S., Lang, R., Mulloy, A., Franco, J., O'Reilly, M., Didden, R., & Lancioni, G. (2010). *Use of Computer-Based Interventions to Teach Communication Skills to Children with Autism Spectrum Disorders: A Systematic Review. Journal of Behavioral Education, 20(1), 55–76.* doi:10.1007/s10864-010-9112-7 . Retrieved at https://www.academia.edu/13986632
28. Ramdoss, S., Lang, R., Fragale, C., Britt, C., O'Reilly, M., Sigafoos, J., … Lancioni, G. E. (2011). *Use of Computer-Based Interventions to Promote Daily Living Skills in Individuals with Intellectual Disabilities: A Systematic Review. Journal of Developmental and Physical Disabilities, 24(2), 197–215.* doi:10.1007/s10882-011-9259-8. Available at https://www.academia.edu/13986642
29. Räsänen, P., Salminen, J., Wilson, A. J., Aunio, P., & Dehaene, S. (2009). *Computer-assisted intervention for children with low numeracy skills. Cognitive Development, 24(4), 450–472.* doi:10.1016/j.cogdev.2009.09.003. Available at https://sci-hub.se/ 10.1016/j.cogdev.2009.09.003
30. Roberto Suson , Eugenio Ermac (2020). *Computer Aided Instruction to Teach concepts in Education. Internal Journal on Emerging Technologies ,11(3),47-52.* Retrieved at https://www.academia.edu/43582098
31. Root, J. R., Stevenson, B. S., Davis, L. L., Geddes-Hall, J., & Test, D. W. (2016*). Establishing Computer- Assisted Instruction to Teach Academics to Students with Autism as an Evidence-Based Practice. Journal of Autism and Developmental Disorders, 47(2), 275–284.* doi:10.1007/s10803-016-2947- 6 . Retrieved at https://sci-hub.se/10.1007/s10803-016-2947-6
32. Shimizu, H., & McDonough, C. S. (2006). *Programmed Instruction to teach pointing with a computer mouse in preschoolers with developmental disabilities. Research in Developmental Disabilities, 27(2), 175–189.* doi:10.1016/j.ridd.2005.01.001 . Retrieved at https://www.academia.edu/20527259
33. Smith, B. R., Spooner, F., & Wood, C. L. (2013). *Using embedded computer-assisted explicit instruction to teach science to students with autism spectrum disorder. Research in Autism Spectrum Disorders, 7(3), 433–443.* doi:10.1016/j.rasd.2012.10.010 . Available at
34. https://sci-hub.do/https://www.sciencedirect.com/science/article/pii/S1750946712001419 Vernadakis, N., Avgerinos, A., Tsitskari, E., & Zachopoulou,

E. (2006). *The Use of Computer Assisted Instruction in Preschool Education: Making Teaching Meaningful. Early Childhood Education Journal, 33(2), 99-104.* Doi:10.1007/s10643-005-0026-2. Available at https://www.academia.edu/335065541

35. Yogesh M. Nandurkar, B.B. Bahule (2014). *The Effect of Computer Assisted Instruction Material as Teaching Aid on Chemistry Learning of High School Students. Scholarly Research Journal For Interdisciplinary studies,2(14),2131-2136.* Retrieved from https://www.academia.edu/10204450
36. Yilmaz Mutlu, Levent Akgun (2017). *The Effects of Computer Assisted instruction Materials on Appropriate number skillsof students with Dyscalculia. The Turkish online Journal of Educational Technology16(20), 119-136.*

VISION FOR EDUCATION 2030: GLOBAL AND INDIAN PERSPECTIVES WITH SPECIAL FOCUS ON TECHNOLOGY IN SPECIAL EDUCATION

Dr. Sree Priya
Ramamurhty, Regional Drector I/c,
National Institute for Empowerment of Persons with Visual Disabilities - Regional Centre (Divyangjan), 522, Trunk Road, Poonamallee, Chennai

Abstract

The education system is progressing with rapid shift in the 21st century catering to the influences of technological advancements, shifting socio-political contexts and ecological uncertainty. The Vision for Education 2030 is a global and national initiative signifies collective assertion to redefine education learning systems to be resilient, equitable and inclusive. In this article the, author focuses upon both Indian and International vantage points on sustainable development, technological integration, policy frameworks and equitable inclusive practices. Special attention is devoted to the intersection of technology and inclusive digital platforms in enlightening the universal learning outcomes for children with disabilities for superior social justice, innovation and community resilience with focus with goals of SDG and National Education Policy (NEP) 2020

Keywords: *Education 2030, Sustainable Development Goals, NEP 2020, Technological integration, Inclusive Education, Children with Disabilities*

Introduction

The dynamic education system envisions with manifestation of global awareness that traditional educational systems must evolve to be more inclusive, fair, equitable and technology driven. These aspirations are part of Vision for Education 2030, that is to achieved by the year 2030. India is taking steps towards aligning its national goals with Sustainable Development Goal 4 (SDG 4) that emphasizes inclusive, quality education and Universal learning opportunities for all. In India, with 2.2 million children are recorded with disabilities (Census 2011), incorporation of inclusive education and assistive technologies in teaching and learning is inevitable for attaining universal learning outcomes. This paper focuses upon Vision for Education 2030 in both Indian and International perspectives, demonstrating how technology sets enabler role in shaping the special education and ensuring that children with disabilities to gain their optimum experiences

Objectives

The aim of the article is to:

- Gain knowledge about global and Indian Commitments to Education 2030 in relation to Inclusion and technology
- Examine the role of assistive technologies in enhancing the expected learning outcomes from children with disabilities
- Sensitize the attention to focus upon the implementation breaches by contrasting policy frameworks on legitimate grounds

- Explore how UDL, teacher preparation and community involvement tend to advance inclusive reforms
- Acclamation of tactics for sustainable, scalable and equitable technology integration

The Global Commitments and SDG 4, Framework

A strong foundation for inclusive education is established by global policy initiatives such as Salamanca Statement (1994), UNCRPD (2008) and the Incheon Declaration (2015). These frameworks require countries to create learning environments that are accessible to every learner regardless of their disability, gender or socio-economic background. The SDG 4 emphasises to ensure equitable, inclusive and high-quality education, rather than advancing the school environment.

The post COVID period marked a rise in worldwide endeavours to establish robust and user-friendly digital learning infrastructures. The UNESCO, UNICEF and the World bank eventually collaborated to provide guidelines and fundings that prevent students from being marginalized, particularly those with disabilities. The focus of Education 2030 is no longer limited to rhetoric, as global programs or initiatives now vigorously encouraging revolution in assistive technology, gender-sensitive learning environments and heightened teacher grounding. In actual practice, this led to the development of digital learning platforms with built-in accessibility, open- source assistive technology and data collection strategies that are disabled friendly.

However, it is vibrant to critically examine whether developing countries like India can really access digital learning platforms essentially creates opportunities for inclusion, when its current education system is exposed to challenging factors such as facilitation of basic infrastructure, technology access, teacher preparation and alike in comparison to the developed countries have access in facilitating intrinsic digital learning platforms and requisite comprehensive factors for education of all children.

The Indian Vision for Education 2030

The National Education Policy (NEP) 2020 is a break through reform in India, obviously encouraged equity and inclusion. It recognizes the difficulty of children with disabilities and suggests a multi-layered strategy to combat this. The National Education Policy (NEP) 2020 advocates for early screening of children with disabilities, inclusion of Indian Sign Language (ISL) in classrooms, establishment of barrier-free infrastructure and promotion of inclusive pedagogy. It encourages Open and Distance Learning (ODL), digital platforms like DIKSHA and context-specific e-content that caters to diverse learning needs

Although this reflects the global SDG vision, it is also tailored to account for India's cultural diversity, language and geographic location. The combined effect between NEP (2020) and the Rights of Persons with Disabilities Act, 2016 forms a strong legal basis for advancing inclusive education in public schools. The actual trial lies in warranting that these frameworks are operationalized homogenously across states and schools when there are persistent bottlenecks related to aspects of training, infrastructure and awareness.

Technology and Special Education

Students with disabilities are nowadays able to access and engage their educational needs through use of technology in special education. Technology transformed access to learning for students with sensory cognitive or physical impairments with the help of assistive technologies like screen readers, Braille embossers, electronic magnifiers, communication apps such as Avaz, and text -to-speech or speech back tools. With the advent of more affordable smartphones and internet access, India has also embraced the use of accessible educational resources. The accessibility gap in getting reduced by the emergence of apps that can teach Indian languages, voice-controlled learning modules and AI-powered reading aids.

The Government's initiatives such as Sugamya Pustakalaya, a web-based collection of easily accessible books and ePathshala, offers multimedia learning in formats appropriate for different learners are worth stating. The National Digital Education Architecture (NDEAR) and PM eVidya are designed to provide inclusive digital learning ecosystems caters to the needs of children with disabilities

However, challenging credits such as lack of electricity and digital connectivity in rural areas, inadequate teachers lack adequate training to integrate technology, poor contextual adaptations of imported technologies ill-suited to Indian linguistic and cultural contexts, still persists. There exists need for community- based tech access points and engagement of local innovators in such instances. At this juncture, it is to be converged that inclusion of technology not to be viewed as mere device distribution but as an ecosystem expansion that warrants serviceability, maintenance and pedagogical integration.

Indulgence of UDL and Inclusive Education

The Universal Design for learning approach forestalls student diversity and projects flexible curricula from the outset. It promotes multiple means of representation, engagement and expression, thereby tumbling the necessity for retrofitted accommodations. The implementation of UDL principles into curriculum frameworks is a promising trend in India, but it's still relatively in infant stage. States are encouraged to incorporate inclusive practices in teaching modules through Samagra Shiksha. NISHITA programs have begun to include approaches that consider disability and UDL as part of its training. In some states, textbook material is promoted to include more include more inclusive imagery and flexible assessment formats. This reform needs to be vitalized with systemic change in teacher education programs as foundational pedagogical philosophy rather that treating inclusion as an add-on factor.

To uplift the UDL to national standard, collaboration with persons with disabilities in curriculum co-design is mandatory. Such participatory approaches enhance the authenticity and practical relevance could enrich the probability of social acceptance of inclusive education.

Capacity Building and Teacher Training

Inclusion in education is direly dependent on teachers. Having a self-reliant, alert and competent teacher can enhance the learning experience of children with disabilities. NCTE guidelines and the NEP 2020 emphasize the importance of inclusive education components in pre-service teacher training. Moreover, in-service training programs like NISHITA and DIKSHA portal offer courses on inclusive teaching methods, classroom settings and assistive technology usage. However, many teacher training institutions still do not have infrastructure, faculty or inclusive practicum sites to prepare teachers effectively. As a result, many teachers enter classrooms unprepared to deal with the diversity present in their environment. The gap can be tapered by enhancing fieldwork, peer monitoring as well as reflective practices.

Block -Level Inclusive Education Resource Teachers (IERTs) and Localized resource centre can serve as a means of handholding support for mainstream teachers. In addition, the training must progress beyond awareness to develop practical skills in creating inclusive lesson plans, developing Ips and utilizing low-tech and High-tech assistive technology. This in fact can bridge the gap between classroom reality and policy intention.

Inclusive Assessment Reforms

A comprehensive approach to assessment is essential for achieving equitable education. Children with disabilities are frequently marginalized by traditional evaluation methods, which manly involve written tests. In line with Education 2030, assessment system must no longer be based on strict summative methods but are instead be more flexible, learner-centred and formative in nature.

Assessments for children with disabilities should encompass not only academic knowledge but also social, emotional and behavioural characteristics. The CBSE has made significant advancements in inclusive assessment by introducing guidelines for children with special needs, which include options for alternative question papers, the use of scribes and extended time. Nonetheless, numerous instructors are either unfamiliar with those guidelines or lack the expertise to implement them proficiently. Besides, tests commonly cannot incorporate diverse expressions such as oral or pictorial responses, which are crucial for comprehensive evaluation.

Emerging digital tools like Prashnavali and e-Samiksha holds potential accessible features like voice input, sign language integration and feedbacks using symbols. It is necessary for states to provide educators with individualized assessment methods and uniform procedures for providing accommodations. The ultimate goal should be strength-based evaluation that enhances learner motivation, confidence and anxiety reduction suiting the diverse needs and adaptations required by children with disabilities.

Accessible Infrastructure and Learning spaces

It is cognized fact that the backbone for any inclusion is physical and emotional accessibility. The RPwD Act 2016 mandates that schools to be barrier-free and accessible for all. Despite this many Indian schools still lack ramps, tactile flooring, accessible washrooms and auditory signals. Rural and under-resourced areas continue to face a significant gap between policy and implementation giving pace for queries. Funding under Samgra Shiksha for inclusive infrastructure has improved access, but periodic audits reveal gaps in maintenance and utilization. Creating inclusive spaces for different disabilities is often hindered due to lack of technical guidance in schools.

The idea of "accessible learning spaces" must extend beyond physical access to include emotional and cognitive safety, such as providing quiet zones for autistic learners, ergonomic seating for those with cerebral palsy and inclusive classroom structure that encourage collaborative learning. Regular accessible audits backed by local authorities and NGOs to be implemented. Additionally, involvement of students with disabilities in infrastructure planning and review can lead to more responsive and sustainable designs

The significance of Families and Communities in Inclusive Education

Families and Communities are critical associates in attaining inclusive education. Parental involvement adopts individual support but stigma, lack of awareness inadequate resources often limit participation. The Right to Education (RTE) Act requires School Management Committees (SMCs) to include parents of disabled children and allow them to participate in planning, budgeting and oversight. This is crucial part of legislation, yet many remain nominal participants.

Active engagement through workshops, support groups and awareness campaign can bridge this gap. The Community Based Rehabilitation (CBR) workers, Anganwadi workers and local leaders pay an important role in identifying children with disabilities and connection with support services at the community level, The efforts of faith-based organizations, self -help groups and youth clubs can also aim to reduce the stigma. The accomplishment of inclusion depends on sustained association among educators, families and local organizations that communally nurture inclusive values.

Monitoring, Data and Accountability Mechanisms

Inclusion in education requires effective monitoring and evaluation methods to maintain quality and accountability. Education 2030's goals are hindered by lack of dependable, comprehensive data about students with disabilities. This particularly problematic. Without correct information, planning resource allocation and evaluation become fragmented and ineffective. The introduction of new fields in India's Unified District Information System for Education Plus (UDISE+) has resulted in a significant improvement. Concerns ascertain about the quality and consistency of data entry. Due to inadequate training in identifying and categorizing disabilities, many teachers and administrators tend to underreport or misinterpret them. Therefore, interventions are either poorly targeted or completely absent in areas where they are most needed. The gaps need to be bridged by implementing regular disability mapping exercises that involve cross-sectoral teams from health, social welfare and education departments.

A change in policy is necessary to implement technology-based dashboards that record enrolments, retention rates, assistive device usage and progress of children with disabilities. Social audits, student feedback and parental surveys can create transparent and responsive accountability systems. Reliable data must inform policy refinement, budget allocation and training strategies at every administrative level.

Innovation in the field and Case studies

Grassroot innovations in India highlight the transformative potential of localized inclusive practices. For instance, Tactile kits and audio-enhanced science experiments are used in inclusive STEM education programs in Tamil Nadu to assist children with visual impairment in engaging with science. During the COVD-19 pandemic, Indian Sign Language introduction in the online classrooms in Kerala bridged the communication barriers of students with hearing impairment. These initiatives indicate a growing realization that inclusion to be present both in policy and in practice forms.

NGOs have been instrumental in piloting inclusive practices that can be expanded with the aid of government. Sense India has developed community-based approach to identify and treat children with deaf- blind, while Vidya Sagar in Chennai has created an environment that integrates education therapy and vocational training for children with multiple disabilities. Similarly public private partnerships are testing AI based diagnostic tools for early identification of learning disabilities. Social- Emotional Learning (SEL) has been made accessible in inclusive classroom through the gamification and digital methods of the MGIEP project of UNESCO.

However, scalability remains a concern. Effective pilot programs often fade when moved to resource-poor contexts deprived of contextual adaptation or sustained funding. Thus, innovation must be paired with policy integration capacity building and equitable financing to ensure long term impact.

Conclusion

The vision for Education 2030 presents an ambitious but essential roadmap for creating inclusive, equitable and empowering education systems globally and in India. With the NEP 2020 and RPwD act providing a robust policy framework, the emphasis must not shift to consistent implementation, adequate financing and capacity building at every level of the education system. Technology, when used thoughtfully and inclusively, can be a gamechanger, particularly in special education bridging gaps in terms of accessibility, engagement and learning outcome.

To make this vision a reality, India must:

- Institutionalize inclusive education within all teacher education programmes, making it a core part of pedagogy, not a niche topic
- Ensure universal access to assistive technology by subsidizing devices, training users and building local level supports
- Redesign curriculum and assessments through UDL principles making learning flexible and responsive

- Strengthen community participation by e powering families, local bodies, civil society organizations to build together conducive inclusive learning environments
- Establish smart data guided planning systems and feedback loops, to ensure accountability, transparency and steady progress

The vision for 2030 is not just a policy goal, it is a social contract that promises every child irrespective of ability, the right to learn, contribute and thrive in a compassionate, inclusive and technologically enriched world with optimum success.

References

1. CBSE. (2022). Policy Guidelines for Children with Special Needs (CWSN) https://WWW.cbse.gov.in/cbsenew/documents/CWSN-Guidelines.pdf
2. Census of India. (2011). Data on Disability. Registrar General and Census Commissioner, Government of India. https://bpaindia.org/wpcontent/uploads/2020/11/Disability_2011_Data Release_DEC 2013.pdf
3. Florian, L., & Spratt, J. (2013). Enacting Inclusion: A Framework for interrogating Inclusive Practice. European Journal of Special Needs Education, 28(@). 119-135. https://legislative.gov.in/sites/default/files/A2016-49_1.pdf
4. Government of India. (2016). The Rights of Persons with Disabilities Act, 2016. Ministry of Law and Justice https://legislative.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
5. Ministry of Education, Government of India. (2020). National Education Policy 2020. Misra. S. (2019) Assistive technology and its role in inclusive education in India. Journal of Disability Studies, 5(2), 48-55. https://doi.org/10.3126/jds.v5i2.26959
6. NCERT. (2020). Universal Design for Learning Guidelines for Curriculum Developers. New Delhi. National Council of Educational Research and Training
7. NCTE. (2021). Guidelines for inclusive teacher education curriculum. National Council for Teacher Education https://ncte.gov.in/Website/PDF/Guidelines_for_IE.pdf
8. Sarkar, A., & Mahapatra, P. (2020). Inclusive education in India: A review of Policies and Practices. International Journal of Inclusive Education, 24(5), 461-478 https://doi.org/10.1080/136031162018.1467973
9. Sense India. (2022) Innovative community- based inclusive education models. https://senseindia.org/programs/education
10. Singal, N. (2019). Schooling Children with Disabilities: Parental Perceptions and Experiences. International Journal of Inclusive Education, 23 (2), 188-204 https://doi.org/10.1080/13603116.2018.1427152
11. UNESCO MGIEP. (2022). Social and Emotional Learning (SEL) for inclusive classrooms https://mgiep.unesco.org/sel
12. UNESCO. (2025), Incheon Declaration and Framework for Action: Towards inclusive and equitable quality education and lifelong learning for all https://unesdoc.unesco.org/ark:/48223/pf0000245656

13. UNESCO. (2020). Global Education Monitoring Report: Inclusion and Education- All means all. Paris. UNESCO Publishing https://unesdoc.unesco.org/ark:/48223/pf0000373718
14. UNICEF. (2021). Reimagining education: Digital access and learning during COVID-19 https://www.unicef,org/reports/remaining-education
15. Vidya Sagar. (2021). Integration education and therapy approaches https://www.vidyasagar.con.in
16. World Bank. (2021). Transforming Education for Disability Inclusion https://documents.worldbank.org/en/publication/documents-reports/documentdetail/555321633939266470

EVIDENCE-BASED PRACTICES AND OUTCOME EVALUATION ON UNIVERSITY PROGRAMME - DIPLOMA IN OFFICE AUTOMATION AND ASSISTIVE TECHNOLOGY FOR PERSONS WITH DISABILITIES

B. Nithya Prabha M.SC.,M.Ed. (Spl.edn(ASD)),
Lecturer(c), NIEPMD, Chennai

Abstract

The pursuit of higher education plays a transformative role in the lives of persons with disabilities (PwDs), offering avenues for personal growth, enhanced employability, social inclusion, and empowerment. Recognizing this potential, the National Institute for Empowerment of Persons with Multiple Disabilities (NIEPMD), in collaboration with Bharathidasan University, Centre for Differently Abled Persons (CDAP) launched the Diploma in Office Automation and Assistive Technology (DOAAT) – a first-of-its-kind, credit-based, inclusive higher education program in India.

Targeted specifically at individuals with Intellectual Disabilities, Autism Spectrum Disorder, Mental Illness, Specific Learning Disabilities, and Multiple Disabilities, the DOAAT program is designed to impart digital literacy, operational proficiency, and familiarity with assistive technologies. The one-year course, structured across two semesters, emphasizes computer operation, software application skills, and exposure to emerging trends in assistive technology. By aligning with the Rights of Persons with Disabilities Act, 2016 and the objectives of the National Education Policy, the program not only supports educational aspirations but also strengthens pathways to employment through the 4% reservation policy for PDs. As the program enters its second year, plans to expand into two- and three-year degree-level offerings reflect NIEPMD's long-term vision to champion inclusive and skill-based higher education.

Introduction

Higher education represents a cornerstone for empowerment, especially for persons with disabilities, offering numerous benefits including personal development, skill acquisition, improved quality of life, social inclusion, and access to employment. It promotes advocacy, independence, and the self-assurance to participate actively in society in addition to academic understanding. Despite these benefits, access to inclusive, skill-oriented higher education has historically been hampered for those with multiple disabilities.

Inclusion in higher education is essential for achieving equitable opportunities for persons with disabilities. While education enables social mobility and independence, individuals with multiple and neurodevelopmental disabilities have historically faced barriers in accessing skill-oriented, structured academic programs. In response, the National Institute for Empowerment of Persons with Multiple Disabilities (NIEPMD), a premier institution under the Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment, Government of India, has undertaken a pioneering initiative. In academic collaboration with Bharathidasan University, NIEPMD introduced the *Diploma in Office Automation and Assistive Technology (DOAAT)* in 2023–24. This initiative marks a significant milestone in advancing inclusive higher education in India.

The DOAAT program is designed specifically for individuals with Intellectual Disabilities, Autism Spectrum Disorder, Mental Illness, Specific Learning Disabilities, and Multiple Disabilities. It provides practical training in digital tools and office applications while also exposing students to assistive technologies that can bridge accessibility gaps. The programme was commenced with an intake of just ten students per academic year, the program offers personalized support, a structured and policy-aligned curriculum, and a direct pathway toward employment and independent living. The DOAAT program offers a policy-aligned, practice-based curriculum tailored to students with diverse support needs. With a limited enrollment to ensure individualized attention, the course offers hands-on training in digital tools, office applications, and assistive technologies — preparing students for both employment and independent living.

By aligning its structure with the Rights of Persons with Disabilities Act, 2016, which mandates a 4% reservation in employment (including 1% for individuals with specific and multiple disabilities), and the guiding principles of the National Education Policy, the DOAAT initiative underscores NIEPMD's role as a catalyst for educational inclusion. With plans to scale the program into a two- or three-year degree course, NIEPMD is setting a benchmark for accessible, future-oriented, and transformative education for persons with disabilities in India. The initiative embodies India's commitment to inclusive education and the empowerment of PwDs, aligning with both national policies and international frameworks such as the UNCRPD.

Education for children with special needs through ICT:

Children with special needs (CWSN) benefit significantly from information and communication technology (ICT), which also helps to break down barriers and promote inclusivity. ICT offers tools and resources that address the various learning needs and styles of students with conditions like autism spectrum disorders, learning disabilities, visual and hearing impairments, and physical disabilities.

ICT enables children with special needs engage in the following ways:

Enhanced usability

ICT provides an extensive variety of assistive technologies (AT) that fill in the gaps triggered by disabilities. For individuals with visual impairments, digital material and interfaces can be accessed through screen readers, Braille displays, and software that magnifies images. For individuals with hearing loss: Access to auditory information is made feasible by assistive listening devices such as remote microphone systems and video captioning software. For students with motor impairments: Despite physical constraints, students can connect with computers and learning materials using modified keyboards, trackballs, joysticks, and speech recognition software.

Apps with customised material, personalised learning platforms, and text-to-speech software can all help with reading comprehension and engagement for students with learning difficulties (like dyslexia).

Facilitate Personalized Education

ICT affords teachers the ability to design resources and lesson plans that are specific to the needs and learning styles of each individual student. Depending on each learner's progress, adaptive learning platforms and software can modify learning styles and levels of difficulty.

Students with dyscalculia can benefit from tools such as math applications that allow them to practice at their own pace and level.

Promotes Inclusive Classrooms

By offering online venues and resources for students with and without impairments to collaborate on projects, ICT promotes collaborative learning.Students benefit from increased empathy, collaboration, and social inclusion, which helps kids with special needs feel like they belong.

Improves Motivation and Involvement

ICT-provided interactive, visually stimulating, and gamified learning opportunities might draw in CWSN who would find it difficult to engage with conventional approaches.A fun and interesting approach to practise skills and learn new ideas is through educational games and applications.

Enhanced mobility and communication

Speech-generating software and augmentative and alternative communication (AAC) devices help kids who have language difficulties or speech impairments express themselves.According to the 21K School, ICT tools increase pupils' autonomy and self-confidence by enabling them to complete activities with little help.

The emergence of higher education for Individual with special needs

Change in a view towards disability and an emphasis on human rights have led to a change from segregation to inclusion in higher education for children with exceptional needs. By offering assistance, instruction, and access to students with disabilities, programs such as Higher instruction for Persons with Special Needs (HEPSN) seek to provide an inclusive atmosphere in postsecondary educational institutions.

Higher Education for Persons with Special Needs (HEPSN): Funded by the University Grants Commission (UGC), this program aims to make higher education institutions more inclusive by giving students with disabilities access, assistance, and awareness.

NEP 2020: The National Education Policy

In order to guarantee that all students, including those with disabilities, have access to high-quality education, the NEP places a strong emphasis on inclusive education.

The RTE Act of 2009:

All children between the ages of 6 and 14—including those with disabilities—must receive free and compulsory education under this statute, which also guarantees their access to local schools.

Literature Review

Collins et al. (2008) has investigated CAI's influence on student evaluations and academic performance in a private institution. Results indicated no significant difference in student evaluations, but regular homework completion correlated with better test scores. Ayvaci & Devecioglu (2009) have compared CAI and traditional methods in preschool education. Results showed CAI was more effective for teaching concepts and positively influenced social development. Fong Peng et al. (2009) analyzed CAI in early childhood literature teaching in Malaysia. CAI improved story engagement and understanding, with audio and video elements enhancing interaction. Chang (2010) compared teacher-centered vs. student-centered multimedia CAI on tenth-grade science achievements. Teacher-centered CAI was more effective in promoting science knowledge. Aktaruzzaman & Muhammad (2011) has also compared CAI and traditional methods in educational research. CAI was more efficient and engaging, leading to better student achievement.

Nandurkar & Bahule (2014) had studied CAI and lecture methods in high school chemistry. Blending CAI with lectures improved learning outcomes.Tolbert Jr. (2015) analyzed CAI's impact using the P.L.A.T.O software, finding neutral performance compared to traditional methods. Nazimuddin (2015) had outlined various CAI modes and their effectiveness in education, concluding that CAI is a globally effective media. Chukwuedozie (2016) investigated CAI's effect on secondary school chemistry students. CAI significantly improved academic achievement and interest.

Jenny R. Root et al. (2017) carried out a review of 29 studies confirmed that CAI is an evidence-based practice for teaching academics to students with ASD, supporting its use in literacy, math, science, and social studies. Uma K. & Manikandan K. (2018) had developed an app to improve conversation skills in children with autism. With 10 participants, the app facilitated communication, demonstrating the potential of technology-based interventions for enhancing communication skills.

In the year 2019, Latika Nidre carried out a review on use of technology to enhance teaching and learning at Aryavidya mandir. They have used collaborative tools on share documents, projects and edit them in real scenario. She stated that these online simulation helps them to improvise their self-learning and thus developing tolerance and social responsibility.

Nishu Tyagi in 2022, explored the importance of assistive technology, its current trends and practices to fulfill the functional needs of peoples with disabilities. Evidences suggested that the several ATs could support people with disabilities to secure their employment, education and careers.

By reviewing all the methods and techniques in the literature indicated that each method has its own merits and demerits. To overcome the demerits an innovative intelligent computer assisted instruction and the significance improvement in higher education for persons with disabilities in this research work.

Methodology

The methodology of the proposed research work includes population, sample and sampling technique, research design, evaluation of the tool, data collection procedure, intervention, processing of data and plan for data analysis. This study has been conducted at DAIL NIEPMD to find out the **Evidence-based practices and Outcome Evaluation on University Programme - Diploma in Office Automation and Assistive Technology for Persons with Disabilities**. The samples were selected from the programme DOAAT at DAIL NIEPMD.

Sample Selection and Description

The sample consist of 10 Individuals with disabilities. The samples were selected based on purposive sampling technique. The groups of the individual ranges from 17 to 21 years of age were taken from the DAIL department at NIEPMD pursuing their higher education of DOAAT in collaboration with Bharathidasan University, Tiruchirappalli. The assessment and diagnosis of individuals was done by Rehabilitation professionals and document was maintained by the institute. The demographic data of the collected samples were grouped and research done as one group- pretest and posttest for evaluating the performance and difference observed after completing the programme.

Inclusion and Exclusion Criteria

Individual meeting ICD-10 criteria for autism spectrum disorder and intellectual disability attending DOAAT programme with mild to moderate disability were included.Individuals with serious physical or mental problems, chronic neurological conditions such as cerebral palsy or epilepsy, were excluded.

Quasi-Experimental Design

The researcher employed a quasi-experimental design to estimate the causal impact of an intervention on a target population without random assignment. This design aims to establish a cause-and-effect relationship between pre and post variables. Initially, the researcher identifies the variables and makes them into one group: receiving treatment (experimental group) .The quasi-experimental design used is the non-equivalent group design, which is effective because it allows for pre-post testing. A pretest is conducted before the intervention i.e before entering into the programme, and a post test is done after its course completion, the conceptual framework was structured accordingly.
In this nonequivalent group design, the group undergoes the intervention:
Experimental group: Pre-test → Intervention (X) → Post-test

Conceptual Framework

The conceptual framework and the design of the proposed research work is shown . The researcher followed the one group experimental design where the sample size is 10. The samples were selected on purposive sampling technique. The researcher have made as the group as experimental group . In experimental group 10 people with moderate and mild intellectual disability, ASD were selected and have given intervention with the help of computer assisted instructions along with traditional way of classroom teaching. The individuals were given pretest to check their level of previous knowledge on the content. The researcher had noted down the score. After completing intervention, they were given posttest.

Tools and Variables: The researcher had utilized standardized tool on Vocational Assessment and Programming System and self-made tools on computer skills.

Procedure

Identification of Sample: Ten Individuals with benchmark disabilities comprising of ASD and intellectual disabilities were the subject of experimental group. The experimental group consisted of adult with mild/moderate disabilities who have verbal communication and are in inclusive education at DOAAT Course DAIL NIEPMD.

Tool Development and Implementation: The study involves on developing their life skills and learning ability , involving:

- Pretest and posttest on standardized and self-made tools.
- An intervention Application of learning skills.

Informed Consent: Parents received informed consent forms detailing the study, investigator, confidentiality clauses, and purpose. Consent was obtained for individuals aged 17-21 years.

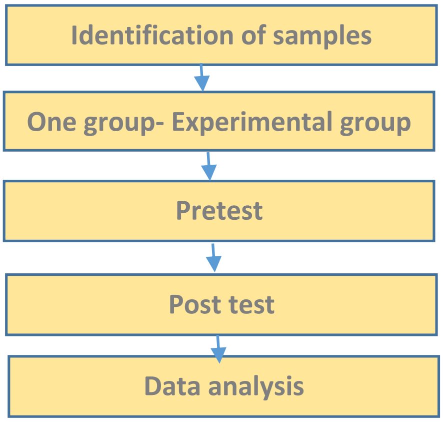
Pre-test: Personal details were collected, and pretests were administered to the group. Data were saved in an Excel sheet for analysis.

Intervention: The intervention covered the curriculum Content was delivered through computer instruction, one topic at a time.

Reliability of Achievement Test Tool: Test items were organized by system for reliability. The students were independently assessed, showing a high positive correlation among evaluations. Test-retest methods determined tool consistency.

Validity of Achievement Test Tool: Content validity was ensured by circulating the tools and evaluation to the faculties at DAIL Department, NIEPMD. Feedback was recorded, discussed with a guide, and incorporated as approved.

Data Collection Procedure: The teachers collected pretest and posttest scores for the one-group experimental method. Testing conditions were maintained for analysis. Consent was obtained from students and parents, who were informed in their native language. The intervention, lasting 1 to 11 months, used computer learning and traditional teaching methods for the experimental group. Sessions were conducted in a distraction-free classroom. Evaluations were done every 3 months once, with a posttest after the intervention. Data were collected and recorded.



Developments under the DOAAT Program

This one-year inclusive, skill-based higher education program focuses not only on academic instruction but also on life skills, independence, and employment **Developments under the DOAAT Program**

This one-year inclusive, skill-based higher education program focuses not only on academic instruction but also on life skills, independence, and employment readiness. The program aligns with the Rights of Persons with Disabilities Act, 2016, and the goals of the National Education Policy, offering students both educational access and employment pathways.

One of the primary areas of student development has been in ***personal hygiene and grooming.*** Through regular training and demonstration, students learned the importance of self-care, cleanliness, and proper attire. This has improved their health, confidence, and employability. Another area of growth is ***independent travel training***. Students who were earlier dependent on caregivers are now able to travel short distances independently, understand road safety, and use public transport. These developments have enhanced their confidence, mobility, and social inclusion.

The program has also introduced students to ***basic financial literacy***, including identifying currency, using calculators, making small purchases, and understanding budgeting and saving. This is essential for independent living and future work environments. Improvements in ***social interaction and communication*** were also significant. Structured group activities helped students learn to greet, converse, follow instructions, and express their needs. This not only reduced behavioral challenges but also promoted teamwork and inclusion.

Punctuality and time management were emphasized, encouraging students to follow daily routines, respect deadlines, and complete tasks responsibly. These are critical skills for any formal employment setting. Additionally, students showed increased ***obedience, cooperation, and team spirit*** through guided group work, classroom rules, and collaborative tasks. They demonstrated better behavior, discipline, and an understanding of structured work environments.

Overall, the DOAAT program has successfully developed both ***technical competencies in computer operations and assistive technologies,*** as well as essential ***life skills.*** These include hygiene, mobility, money management, communication, and teamwork—skills necessary for independent living and meaningful employment. Importantly, the ***computer skills*** learned through this program form the foundation for future job roles or continued higher education, fulfilling the digital literacy needs of persons with disabilities.

The inclusive and outcome-focused design of DOAAT sets a benchmark for accessible and transformative education in India. With plans to expand into two- and three-year degree courses, the program stands as a ***replicable model*** for other institutions aiming to empower persons with disabilities through structured, skill-based, and inclusive higher education.

Importantly, the digital and assistive technology training provided under the DOAAT program equips students with foundational *ICT skills,* positioning them for diverse roles in office and administrative settings or further education. These skills bridge accessibility gaps and fulfill the increasing demand for digital competence in today's job market.

Conclusion

The DOAAT program is an innovative model of inclusive, skill-based education tailored to the diverse needs of persons with disabilities. Its structured curriculum, emphasis on functional independence, and alignment with national disability policies make it a pioneering initiative in India's higher education landscape. With demonstrated student development in both technical and life skills, and future plans for program expansion, NIEPMD is setting a scalable benchmark for accessible education that could inspire similar initiatives nationally and globally.

References:

1. Collins, Alan Deck, Myra McCrickard (2008). *Computer Aided Instruction: A Study Of Student*
2. *Evaluation And Academic Performance. Journal of College Teaching & Learning, 5(11).*Retrieved at https://www.academia.edu/35283704
3. Ayvacı, H. S., & Devecioğlu, Y. (2010). *Computer-assisted instruction to teach concepts in pre-school education. Procedia-Socialand Behavioral Sciences, 2(2), 2083–2087.* doi:10.1016/j.sbspro.2010.03.285 . Retrieved at https://www.academia.edu/5135701
4. Ahiatrogah, P. D., Madjoub, M. B., & Bervell, B. (2013). *Effect of Computer Assisted Instruction on the Achievement of Basic School Students in Pre-Technical Skills. Academic Journal of Interdisciplinary Studies.* doi:10.5901/ajis.2013.v2n1p77 . Available at https://sci-hub.se/10.5901/ajis.2013.v2n1p77
5. Md. Aktaruzzaman , Dr. Khushi Muhammad (2011*). A COMPARISON OF TRADITIONAL METHOD AND COMPUTER AIDED INSTRUCTION ON STUDENTS ACHIEVEMENT IN EDUCATIONAL RESEARCH. Academic Research International,1(3).* Retrieved at https://sci-hub.do/http://www.savap.org.pk/journals/ARInt./Vol.1(3)/2011(1.3-26).pdf

6. SK. Nazimuddin (2015). *Computer Assisted Instruction(CAI): A New Approach in the Field of Education. International Journal of Scientific Engineering and Research.3(7), 185-188.* Retrieved at https://sci-hub.do/http://lcwu.edu.pk/ocd/cfiles/Professional%20Studies/CC%20/B.Ed.-%20104/computerassistedinstruction.pdf
7. Latika Nidre(2019). *Use of Technology to Enhance Teaching and Learning at Arya Vidya Mandir*. SR Publishing house, 54.
8. Nisha Tyagi (2022). *Impact of Assistive Technology on Lives of People with Disabilities.* Jaypee brothers,77, 537-543.

TOOLS FOR SUPPORTING SENSORY AND PHYSICAL DISABILITIES FOR DIVERSE NEEDS

M. Ramya
Ph.D. Research Scholar, Avinashilingam University, Coimbatore

Dr. R. Shanthi
Ph.D. (Special Education), Assistant Professor
Avinashilingam University, Coimbatore

Abstract

This paper presents an expanded review of assistive tools that support individuals with sensory and physical disabilities in educational, social, and technological contexts. The study categorizes tools according to type of impairment (visual, hearing, and motor), comparing traditional and digital solutions with a focus on their effectiveness, affordability, and adoption challenges. It integrates findings from peer-reviewed studies, policy documents, and technology reports to highlight best practices for inclusive implementation. A dedicated literature review synthesizes global research trends, while the conclusion summarizes key takeaways for educators, policymakers, and technologists. The paper also emphasizes the role of universal design, teacher training, and community awareness in maximizing the impact of assistive technologies.

Keywords: *Assistive technology, inclusive education, sensory disabilities, physical disabilities, Universal design, accessibility tools, educational technology*

Introduction

Disability is not a deficit in ability but a mismatch between an individual's functional needs and the environment they interact with. Sensory and physical disabilities, while diverse in manifestation, share a common challenge: environmental and systemic barriers that limit equal participation in education, work, and community life (WHO, 2021). Historically, educational systems have been built on a "one-size-fits-all" model, which disadvantages learners whose needs deviate from the assumed norm (UNESCO, 2020).

The global shift toward inclusive education—driven by frameworks like the United Nations Convention on the Rights of Persons with Disabilities (CRPD)—has increased recognition of the importance of assistive technologies (AT) in closing participation gaps. AT encompasses a spectrum of solutions, from low-tech aids like magnifying glasses to high-tech, AI-driven communication devices. While developed countries have made significant strides in AT integration, disparities remain stark in developing contexts due to financial constraints, policy gaps, and cultural perceptions of disability (Alper & Raharinirina, 2006).

Objectives

The specific goals of this paper are to:

1. **Map the spectrum of AT** used for sensory and physical impairments, categorizing tools into traditional and digital solutions.
2. **Evaluate their impact** on educational access, independence, and social inclusion, drawing from global research.

3. **Identify barriers** to adoption, including affordability, infrastructure, and societal attitudes.
4. **Provide actionable recommendations** for policymakers, educators, and technology developers to ensure equitable and sustainable AT implementation.

Literature Review

Growth of AT Research

Research into assistive technologies has grown rapidly since the early 2000s, fueled by advances in mobile computing, artificial intelligence, and universal design principles (Istenic Starcic & Bagon, 2013). Initially, tools were developed for specific impairments—such as Braille embossers for blindness or FM hearing systems for deafness—but over time, there has been a shift toward inclusive tools that can adapt to varied needs.

Transformative Potential

Studies show that AT can substantially improve learning outcomes and quality of life (Adebayo, 2014; Alnahdi, 2014). For example, screen-reading software allows blind students to access digital textbooks instantly, while AAC devices give non-verbal learners a voice in the classroom. These interventions are not only functional but also social, fostering greater peer interaction and reducing isolation.

Persistent Gaps

Despite their potential, AT adoption is far from universal. Common challenges include:

- **Economic barriers**—Specialized devices can be prohibitively expensive.
- **Training deficits**—Educators may not know how to integrate AT effectively (Edyburn, 2020).
- **Infrastructure issues**—Poor internet connectivity can hinder cloud-based tools.

Policy and Systemic Support

Countries with well-defined funding schemes and teacher training programs report higher AT adoption (Alnahdi, 2014). UNESCO (2020) emphasizes that technology must be embedded in inclusive education policy frameworks to ensure sustainability.

Understanding Sensory and Physical Disabilities

Sensory Disabilities

Sensory disabilities refer to impairments in vision or hearing.

- **Visual Impairments** include low vision, partial blindness, and total blindness. Students with these impairments may require tactile learning materials, screen magnification, or audio description of visual content (Hersh & Johnson, 2010).
- **Hearing Impairments** range from mild to profound deafness. Communication support might involve hearing aids, cochlear implants, real-time captioning, or sign language interpretation (WHO, 2021).

Physical Disabilities

Physical or motor disabilities affect mobility, dexterity, and physical endurance. Causes include congenital conditions (e.g., cerebral palsy) and acquired injuries (e.g., spinal cord injury). Learners with motor impairments may need alternative input devices, adapted furniture, or voice-controlled computing (Cresswell et al., 2019).

Assistive Tools for Visual Impairments

Visual impairments range from low vision to complete blindness, and the degree of impairment often determines the kind of assistive technology (AT) needed. These tools can be classified into **traditional** (non-digital) and **digital** solutions, each serving unique purposes in education, navigation, and daily living.

Traditional Tools

Braille Systems

The **Braille system**—developed by Louis Braille in the 19th century—remains one of the most influential assistive tools for individuals with visual impairments. It consists of a tactile writing system using raised dots arranged in a six-cell configuration.

- **Function**: Allows blind learners to read and write through touch rather than sight.
- **Educational Use**: Widely used in schools for blind students to access textbooks, assignments, and examination materials.
- **Advantages**: Promotes literacy, spelling skills, and independent reading.

Limitations

- Requires tactile sensitivity and training.
- Bulky materials compared to printed text.
- Production of Braille books can be costly.

Example: Perkins Brailler, Braille embosser printers.

Tactile Graphics & Embossed Diagrams

Tactile graphics are visual images transformed into raised-line drawings that can be interpreted through touch.

- **Function**: Enable understanding of spatial concepts like maps, graphs, and diagrams.
- **Educational Use**: Particularly important for STEM subjects, allowing blind learners to grasp mathematical graphs, chemical structures, or geography maps.
- **Advantages**: Enhances comprehension of visual-spatial content, which is often a challenge in traditional teaching.

Limitations

- Time-consuming to produce.
- Requires specialized equipment and skills.
- **Example**: Thermoform machines, swell paper (capsule paper) printing.

Digital Tools

Screen Readers

- Screen readers are software applications that convert text displayed on a screen into synthesized speech or Braille output.
- **Function**: Reads out digital content, including web pages, documents, and emails.

Popular Examples

- **VoiceOver** (Apple) – built into iOS and macOS.
- **TalkBack** (Android) – integrated into Android devices.
- **JAWS** (Windows) – one of the most widely used professional screen readers.

Advantages

- Allows real-time access to digital content.
- Works across multiple applications, from browsing to word processing.

Limitations

- Can be challenging with poorly designed or non-accessible websites.
- Requires training to use advanced functions.

OCR (Optical Character Recognition) Applications

OCR tools scan printed material and convert it into digital text that can be read aloud or converted to Braille.

Function: Bridges the gap between printed content and digital accessibility.

Examples

- **Seeing AI** (Microsoft) – free app that reads text, identifies products, and even describes people's facial expressions.
- **KNFB Reader** – scans and reads printed documents with high accuracy.

Advantages

- Allows instant access to printed material without needing a human reader.
- Supports multiple languages.

Limitations

- Requires a smartphone or tablet with a camera.
- Accuracy may be affected by poor lighting or unclear print.

GPS Navigation Aids

GPS-based assistive tools use auditory feedback to guide visually impaired users through their environment.

- **Function**: Provides spoken directions, points of interest, and environmental descriptions.
- **Example**: **Microsoft Soundscape** – offers 3D audio cues to help users orient themselves in urban environments.

Advantages

- Enhances independent travel.
- Can be combined with mobility aids like a white cane or guide dog.

Limitations

- Requires internet access and GPS signal.
- May not be fully accurate in rural or obstructed areas.

AI-Driven Wearables

AI-enhanced wearable devices combine camera vision and machine learning to interpret the user's surroundings in real time.

- **Function**: Recognizes objects, reads printed and handwritten text, detects faces, and even interprets colors.
- **Example**: **Envision Smart Glasses** – lightweight glasses with built-in AI capabilities for object recognition and scene description.

Advantages

- Offers a hands-free experience.
- Can integrate multiple functions (reading, navigation, identification).

Limitations

- High cost makes them inaccessible to many users.
- Requires ongoing software updates and internet connectivity for some features.

Research Evidence

Adebayo (2014) found that students using digital visual-assistive tools demonstrated improved reading speed, comprehension, and independence compared to those relying solely on traditional aids. However, the study also reported that affordability and device maintenance are major barriers to sustained use in low-income educational settings.

Summary Table

Tool Type	Examples	Key Advantages	Limitations
Braille Systems	Perkins Brailler, Braille embossers	Literacy, independence	Bulky, costly
Tactile Graphics	Thermoform maps, swell paper diagrams	Supports STEM learning	Time-consuming to produce

Screen Readers	VoiceOver, TalkBack, JAWS	Real-time digital access	Website accessibility issues
OCR Apps	Seeing AI, KNFB Reader	Instant text access	Lighting/print quality issues
GPS Navigation	Microsoft Soundscape	Independent mobility	GPS/internet dependency
AI Wearables	Envision Glasses	Multi-function, hands-free	High cost

Assistive Tools for Hearing Impairments

Hearing impairments range from partial hearing loss to complete deafness and can be either congenital or acquired. Assistive tools for individuals with hearing impairments focus on **enhancing auditory perception**, **facilitating alternative communication**, and **providing environmental awareness**. These tools fall into traditional and digital categories.

Traditional Tools

Hearing Aids

Hearing aids are small electronic devices worn in or behind the ear that amplify sound.

- **Function**: Capture sound through a microphone, process it, and deliver amplified audio to the ear canal.
- **Educational Use**: Enables students to follow lectures, participate in discussions, and engage in group activities.
- **Advantages**: Portable, discreet, and available in various designs (in-the-ear, behind-the-ear, completely-in-canal).

Limitations

- Effectiveness decreases with severe or profound hearing loss.
- Requires battery changes or charging.
- Background noise can still interfere with clarity.

Cochlear Implants

Cochlear implants bypass damaged parts of the inner ear to directly stimulate the auditory nerve.

- **Function**: Converts sound into electrical signals transmitted to the auditory nerve via implanted electrodes.
- **Advantages**: Provides a sense of sound to individuals with profound hearing loss who do not benefit from hearing aids.

Limitations:

- Requires surgical implantation.
- Outcomes vary based on age at implantation and rehabilitation support.
- **Example**: Widely used in pediatric early intervention programs.

Visual Alarm Systems

Visual alert systems use flashing lights, vibrating devices, or other non-auditory signals to indicate alarms and notifications.

- **Function**: Provide environmental alerts for fire alarms, doorbells, timers, and phone calls.
- **Advantages**: Improves safety and independence.

Limitations

- May not be effective in bright daylight conditions.
- Installation cost in large buildings can be high.

Digital Tools

Live Transcription Apps

Apps such as **Google Live Transcribe** provide real-time speech-to-text conversion, allowing individuals with hearing impairments to follow conversations or lectures instantly.

Advantages

- Real-time communication in group settings.
- Works across multiple environments, including classrooms and meetings.

Limitations

- Requires internet connectivity for best accuracy.
- Speech recognition may falter with strong accents or noisy backgrounds.

Research Evidence

Marschark & Hauser (2012) found that real-time transcription significantly improves engagement compared to delayed captioning.

Sign Language Learning Apps

Applications like **Lingvano** and **ProDeaf** provide interactive lessons in sign language, enabling both hearing and non-hearing individuals to communicate more effectively.

Advantages:

- Self-paced learning.
- Visual demonstrations and quizzes enhance retention.

Limitations

- May not cover full regional variations of sign language.
- Requires device access and visual attention.

Video Relay Services (VRS)

VRS tools, such as **Glide** and **Rogervoice**, connect deaf users with interpreters via video calls.

Function: Interpreters translate between sign language and spoken language for conversations with hearing individuals.

Advantages

- Facilitates real-time communication with non-sign language speakers.
- Useful for professional and emergency contexts.

Limitations

- Internet-dependent.
- Interpreter availability may vary by location.

Assistive Tools for Physical Disabilities

Physical disabilities affect mobility, posture, and motor control due to conditions like cerebral palsy, spinal cord injuries, muscular dystrophy, or amputations. Assistive tools aim to enhance **mobility**, **communication**, and **environmental control**.

Traditional Tools

Manual and Powered Wheelchairs

- **Manual wheelchairs** are propelled by the user or an attendant, while **powered wheelchairs** use electric motors.

Advantages

- Increases mobility and independence.
- Customizable seating for posture support.

Limitations

- Powered models are costly and require maintenance.
- Accessibility depends on infrastructure (ramps, elevators).

Orthotics

Orthotic devices, such as braces and splints, support or correct the alignment of limbs and spine.

- **Function**: Improves posture, prevents contractures, and assists in movement.
- **Advantages**: Lightweight designs for daily wear.

Limitations

Need periodic replacement as the user grows or condition changes.

Adapted Writing Tools

Weighted pens, pen grips, and slant boards make writing easier for individuals with limited motor control.

- **Advantages**: Improves handwriting stability.
- **Limitations**: Primarily supports short-term tasks and may not replace digital alternatives for long writing needs.

Digital Tools

Switch-Access Devices

Devices like **Tecla** allow mobility-limited users to control smartphones, tablets, and computers through simple switches, head movements, or sip-and-puff controls.

- **Advantages**: Enables independent technology use.
- **Limitations**: Requires customization for each user's physical abilities.

Facial Recognition Controls

The **Eva Facial Mouse** uses head and facial movements to control on-screen navigation, enabling hands-free device operation.

- **Advantages**: Affordable alternative to specialized hardware.
- **Limitations**: Requires good camera positioning and lighting.

Augmentative and Alternative Communication (AAC) Apps

Apps like **Speech Assistant AAC** and **JABtalk** allow non-verbal individuals to communicate through customizable symbols, text, and voice output.

Advantages:

- Enhances communication, self-esteem, and social participation.
- Portable and adaptable for different environments.
- **Research Evidence**: Judge & Simms (2009) found AAC devices boost not just communication skills but also group participation and confidence.
- **Limitations**: Device dependency and training needs.

Smart Home Systems

Systems like **Amazon Alexa** and **Google Assistant** integrate with smart devices to control lighting, doors, appliances, and climate via voice commands.

Advantages: Improves daily living independence.

Limitations

- Requires smart home infrastructure.
- Limited effectiveness for users with severe speech impairments without additional AAC integration.

Educational Integration

Effective integration of AT in education requires:

- Teacher training in both technical use and pedagogical application of AT.
- Multiple content formats to ensure accessibility (Braille, audio, large print, captioned video).
- IEPs tailored to student needs.

Dell et al. (2017) found that co-teaching models—where special educators support general educators—produce better learning outcomes for AT users.

Challenges in Implementation

- **Cost**: Proprietary devices often exceed the budgets of schools and families (Alper & Raharinirina, 2006).

- **Training Gaps**: Without skilled educators, AT remains underused (Edyburn, 2020).
- **Compatibility**: Devices may not integrate with school ICT systems.
- **Social Stigma**: Students may reject AT if it makes them feel different from peers (Shinohara & Wobbrock, 2011).

Future Perspectives

The next generation of AT is likely to:

- Leverage AI for real-time language translation and adaptive learning.
- Integrate biometric health monitoring into learning tools.
- Provide multilingual interfaces to serve diverse populations.
- Expand open-source alternatives to make devices more affordable (Borg et al., 2019).

Conclusion

Assistive technologies for sensory and physical disabilities are essential for achieving equity in education and participation in society. While traditional tools remain indispensable, digital innovations are broadening access and independence. For these benefits to be fully realized, stakeholders must invest in affordability, teacher preparedness, universal design, and policy alignment.

References

1. Adebayo, O. S. (2014). The impact of assistive technology on the academic achievement of students with visual impairments. International Journal of Special Education, 29(3), 1–10.
2. Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal design for learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. Journal of the Scholarship of Teaching and Learning, 16(3), 39–56. https://doi.org/10.14434/josotl.v16i3.19295
3. Alnahdi, G. H. (2014). Assistive technology in special education and the universal design for learning. The Turkish Online Journal of Educational Technology, 13(2), 18–23.
4. Alper, S., & Raharinirina, S. (2006). Assistive technology for individuals with disabilities: A review and synthesis of the literature. Journal of Special Education Technology, 21(2), 47–64. https://doi.org/10.1177/016264340602100204
5. Borg, J., Larsson, S., & Östergren, P. O. (2019). The right to assistive technology: For whom, for what, and by whom? Disability & Society, 34(7–8), 1050–1071. https://doi.org/10.1080/09687599.2019.1583550
6. Burgstahler, S. (2015). Universal design in higher education: From principles to practice (2nd ed.). Harvard Education Press.
7. Cresswell, S. L., Hodge, K., & Van der Ploeg, H. P. (2019). Physical activity for people with physical disabilities: A narrative review of the literature. International Journal of Behavioral Nutrition and Physical Activity, 16(1), 126. https://doi.org/10.1186/s12966-019-0880-9

8. Dell, A. G., Newton, D. A., & Petroff, J. G. (2017). Assistive technology in the classroom: Enhancing the school experiences of students with disabilities (3rd ed.). Pearson.
9. Edyburn, D. L. (2020). Emerging trends in special education technology. Journal of Special Education Technology, 35(1), 3–14. https://doi.org/10.1177/0162643419879255
10. Hersh, M., & Johnson, M. A. (Eds.). (2010). Assistive technology for visually impaired and blind people. Springer. https://doi.org/10.1007/978-1-84882-181-1
11. Hyvarinen, L. (2019). Hearing and learning: Educational challenges for students with hearing impairments. Journal of Hearing Science, 9(2), 9–15.
12. Istenic Starcic, A., & Bagon, Š. (2013). ICT-supported learning for inclusion of people with special needs: Review of seven educational technology journals, 1970–2011. British Journal of Educational Technology, 45(2), 202–221. https://doi.org/10.1111/bjet.12086
13. Judge, S., & Simms, K. (2009). Assistive technology training at the pre-service level: An update. Journal of Special Education Technology, 24(4), 45–49. https://doi.org/10.1177/016264340902400405
14. Marschark, M., & Hauser, P. C. (2012). How deaf children learn: What parents and teachers need to know. Oxford University Press. https://doi.org/10.1093/acprof:osobl/9780199750986.001.0001
15. Parette, H. P., & Blum, C. (2013). Instructional technology in early childhood: Teaching in the digital age. Baltimore: Brookes Publishing.
16. Shinohara, K., & Wobbrock, J. O. (2011). In the shadow of misperception: Assistive technology use and social interactions. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 705–714. https://doi.org/10.1145/1978942.1979044
17. UNESCO. (2020). Global education monitoring report 2020: Inclusion and education – All means all. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000373718
18. United Nations. (2006). Convention on the Rights of Persons with Disabilities. https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf
19. World Health Organization. (2018). World report on disability. WHO Press. https://www.who.int/disabilities/world_report/2011/report.pdf
20. World Health Organization. (2021). World report on hearing. WHO Press. https://www.who.int/publications/i/item/world-report-on-hearing

ENHANCING STUDENTS' ENGAGEMENT THROUGH IOT IN EDUCATION

Dr. S. Samidass
shanmugamsamidass@gmail.com

Abstract

In the context of education, here Internet of Things enables real-time sharing of content, classroom management, own learning experiences, and also provides an interactive digital platform that gives facilitation for student-centred instruction. Overall students' involvement, a straight construct encompassing behavioural, emotional, and dimensions of cognitive play a important role in academic achievement and learning outcomes in their education life. IoT supports revolutionize in education to create their learning effective and students are can focus, also it's a technology that enables physical embedded objects to link the Internet. Students' needs to cover the education curriculum and taught using a development learning approach.

To add more, it is changing the education surface by connecting all their devices and growing interactive sessions with their learning environments. However, this modern generation allows teachers to students involvement and participation, this can track their performance, and can be tailored the coaching of students need and improving teaching, learning instructional outcomes. Through interconnected devices, IoT collects behavioural, environmental, and academic information.

Keywords: *Digital Technology, Virtual Classroom and Platforms, Student Engagement, Motivation, Attention, Student - Teacher Interaction.*

Introduction

The IoT can be described as a network of all interlocking physical devices with sensors, software, and other technologies that gather and distribute information via the internet (Gubbi et al., 2013). When applied to education, it allows real-time exchange of information, classroom control, personal learning experience, and even interactive online environment, which allows student-centred learning.

Student engagement, which is a multidimensional construct that includes behavioural, emotional, as well as aspects of cognitive, is crucial to academic performance and learning outcomes on a broad level (Fredricks, Blunden, and Paris, 2004). Active students will have higher chances of participating in the learning, knowledge retention, and lifelong learning motivation. The outdated pedagogical models are not always sufficient to meet the dynamic needs of learners and the innovative strategies have to be applied to attract the span of attention and depth learning in students.

These technologies offer promising solutions to this challenge by creating more interactive and personalized learning environments and not only streamline classroom management but also enhance students learning experiences to individual needs.

Moreover, IoT facilitates inside and outside of the communication and collaboration both students and teachers, thus a more holistic and inclusive classroom settings. Through connected learning platforms, students can access educational resources 24*7 anytime and anywhere. Teachers can gain valuable insights of information on student behaviour and learning patterns through information analytics, enabling pedagogical decisions (Al-Fuqaha et al., 2015).

Definition

The Internet of Things (IoT) in education involves embedding computational intelligence into traditional classroom learning objects experiences. Through interconnected devices, IoT collects behavioural, environmental, and academic information, which is used to

i. Personalize instruction
ii. Track students performance
iii. Automate classroom functions
iv. Enhance collaboration
v. Extend learning beyond physical boundaries

IoT in education is thus not limited to gadgets. It represents a pedagogical shift towards real-time interaction, feedback, and decision-making in the beyond classroom instruction.

Characteristics of IOT

Connectivity

The IoT infrastructure has a significant need of connectivity. The IoT infrastructure should be connected with things of IoT. They can be connected everywhere, anytime and any time that should be ensured. As an illustration, the relationship between individuals via Internet gadgets such as mobile phones, and other devices is also a relationship between the Internet gadgets such as routers, gateways, sensors, etc.

Intelligence and Identity

It is extremely significant to the surplus of knowledge of the produced data. To take an example, a sensor produces data, and this data will only be helpful in case it is interpreted correctly. The identity of each IoT device is different. This identification assists in tracing the equipment and at times querying its condition.

Scalability

The list of elements that relate to the field of the IoT is growing daily. Therefore, an IoT system must be in a position to manage the gigantic growth. The information produced as a result is huge, and it needs to be addressed accordingly.

Dynamic and Self - Adapting (Complexity)

IoT Architecture cannot be homogenous. It should be hybrid, integrating the products of various manufacturers to work with the IoT network. IoT Nor does anybody own a branch of engineering. IoT is a reality when there are more than two domains come together

Architecture

IoT Architecture cannot be of homogeneous nature. It must be hybrid, allowing to integrate the products of various manufacturers to work on the IoT network. IoT does not belong to any engineering branch. IoT is a reality when various domains are united.

Safety

Internet of Things structures that include behavioural, emotional, and dimensions of cognitive in cases where all his/her devices are networked to the internet. This is able to involve the user to use all the components in terms of education through the modern gadgets such as mobile phones, and other gadgets, as well as a connection between the Internet devices like routers, gateways, sensors, etc.. IoT platforms enable learners to interact and work together in real-time, which encourages peer learning, collaboration, and socialization skills that will make them successful in their given field.

Self - Configuring

This is considered to be one of the most crucial features of IoT. IoT devices can upgrade their software according to the requirements with little involvement of the user. Also, they are able to configure the network and this means that additional devices can be added to an already existing network.

Interoperability

IoT devices have common protocols and technologies to make them be able to communicate with each other and with other systems. One of the main peculiarities of the IoT is interoperability. It is defined as the capacity of various devices and systems of the Internet of things to communicate and share data with one another, irrespective of the technology or manufacturer.

Some of the Stages of IOT Integration for Students Engagement in Education

The Integrating IoT to enhance students' engagement numerous coordinated stages that ensure readiness, proper positioning, effective use, and continuous improvement. Every stage builds upon the previous, addressing both technological and educational dimensions to foster and sustained student engagement.

Stage One: Planning and Needs Assessment

The fundamental of IoT integration begins with a comprehensive planning and needs assessment phase. This involves identifying institutional goals, student engagement, challenges, and educational outcomes that IoT is intended to support.

Key actions

a. The Conduction of survey among the students and teachers to determine the engagement issues.
b. Assess the infrastructure, including internet connectivity, device availability, and security.
c. Define measurable objectives for the students' engagement.

It is the step that makes sure that there is the gap between technology and pedagogical will, that can help the teachers and the students to avoid technology-oriented projects that do not have the educational goal (Uskov et al., 2018).

Stage Two: Infrastructure Development and Technology Selection

Once planning is complete, institutions must invest in the necessary of IoT infrastructure and suitable technologies. This includes hardware and software.

Key actions

a. Upgrade Wi-Fi networks and cloud storage to support real-time sharing retention of knowledge and information.
b. Select the IoT tools based on educational value, scalability, and compatibility with existing systems.
c. Ensure adherence to cyber security and standard privacy to protect student data.

Stage Three: Pilot Implementation and Training

Before full-scale deployment, a pilot program should be implemented in classrooms and subject areas. This stage emphasizes teacher preparedness and interactive learning.

Key actions

a. Train teachers and students in the effective use of IoT tools.
b. "Observe the pilot project for any technical issues, levels of user engagement, and classroom interactions.
c. Gather feedback to improve teaching strategies and address unexpected challenges."

Stage Four: Full-Scale Deployment and Classroom Integration

After refining the processes through pilot testing, IoT solutions are rolled beyond classroom and embedded into each and every day teaching and learning practices.

Key actions

a. Integration of IoT tools into lesson plans and assessment strategies.
b. To encourage the students to use wearable devices, interactive platforms to collaborate and personalized learning.
c. Utilize the data analytics to adaptive teaching based on real-time student behaviour and our feedback.

This stage maximizes students' engagement across behavioural, emotional, and cognitive domains by leveraging the potential of knowledge, personalized, and interactive learning environments (Liu et al., 2020).

Stage Five: Continuous monitoring, Assessment and Improvement

The final stage of the focus on monitoring and evaluation is to assess the impact of the integration of IoT on students' engagement and learning experience and outcomes.

Key actions

a. Utilize the analytics dashboards to monitor / observe the students participation, performance, and emotional responses.
b. Assess the success through engagement metrics likes feedback.
c. Continuously refine instructional strategies and iimplementation of innovative technologies based on evaluation findings.

Contribution of IOT to 21st Century Learning

Personalized and Adaptive Learning

IoT systems collect information on every learner's pace, interests, and level of understanding.

- ✓ IoT improves personalized learning by allowing real-time customization of content and support based on individual learning analytics.(Tariq, Khan, &Rawat, 2020)

Interactive and Engaging Classrooms

Smart boards, clickers, and IoT's are connected students to response systems to get immediate feedback and active participation. By transforming students from passive recipients into active participants, IoT devices enhance cognitive engagement and encourage students' higher-order thinking.

- ✓ The use of IoT technologies transforms the classroom into a dynamic and interactive learning space. (Bharadwaj& Singh, 2021)

Data-Driven Instruction and Feedback

Teachers can use real-time analytics from IoT tools to assess student progress, identify at-risk learners, and adjust their teaching strategies accordingly.

- ✓ IoT-enabled learning analytics allow teachers to understand students' behaviours and tailor teaching strategies to optimize learning.(Zhou, Zhang, & Sun, 2019)

Learning at inside and outside of the Classroom

IoT extends learning to real-world settings through mobile apps, AR-enabled field devices, and smart wearable. Students can perform virtual labs at home or gather scientific information during fieldwork, making learning contextual, autonomous, and continuous.

- ✓ IoT supports ubiquitous learning by enabling 24*7 accesses to educational resources and interactions. (Madakam, Ramaswamy, &Tripathi, 2015)

Promoting 21st Century Skills

IoT-enabled education fosters the development of critical 21st century skills such as:

- ✓ Digital literacy
- ✓ Creativity
- ✓ Communication and collaboration
- ✓ Problem-solving
- ✓ Global and cultural awareness

These skills are essential for success in a knowledge-driven global economy.

- ✓ Technologies like IoT are reshaping education by promoting creativity, adaptability, and digital fluency. (UNESCO, 2018)

Collaboration and Connectivity

With cloud-integrated IoT platforms, students and teachers collaborate beyond the classroom. Group assignments, peer assessments, and discussions become more accessible, supporting collaborative learning, a core component of 21st century pedagogy.

- ✓ IoT tools enhance peer learning and connected classrooms by enabling real-time, device-agnostic collaboration. (Chopra & Rajput, 2020)

Ethical Considerations and Challenges

- ✓ *Digital Divide:* Students in under resourced areas may lack access to the IoT infrastructure.
- ✓ *Privacy and Security:* IoT devices to collect the sensitive information; ensuring cyber security and student privacy.
- ✓ *Teacher Readiness:* Every teacher requires training and support to integrate IoT.
- ✓ *Cost and Infrastructure:* Each and every educational institution needs funding and technical support to maintain IoT systems.

Why Enhancing Student Engagement through IOT in Education is Needed

Declining Traditional Engagement Levels

Traditional classroom teaching often creates distraction, disengagement, and low engagement. But direct interaction, customized content, and unique experiences help rekindle students' interest.

Support for Personalized and Differentiated Learning

Each student learns at a different pace, place, and manner. IoT technologies help create personalized learning paths, collect and analyze each student's information, and deliver content tailored to their needs."

Improved Learning Outcomes through Real Time Feedback

The Internet of Things (IoT) provides instant feedback/feedback to students and teachers, enabling timely correction, guidance, and motivations, helping them understand knowledge and improve performance.

Increased Interactivity and Hands-On Learning

IoT fosters active participation by making lessons interactive through smart devices, simulations, and experiential tools. This hands-on engagement supports deeper cognitive processing and retention.

Facilitation of Collaborative Learning

IoT platforms allow learners to connect and collaborate in real time, promoting peer learning, teamwork, and social engagement skills essential for success.

Inclusive Education for All Learners

IoT devices support accessibility features like speech recognition, wearable aids, and sensor-based learning tools for students with special needs, ensuring equitable learning opportunities.

Real-Time Monitoring for Proactive Teaching

Teachers can monitor students' attention levels, engagement, and emotional states through IoT sensors, enabling early interventions and personalized support.

Bridging the Gap between Digital and Physical Learning Spaces

IoT connects real world learning experiences with digital learning platforms, creating hybrid environments where students engage both in and beyond the classroom.

Support for Lifelong and Anytime Learning

With wearable devices, smart apps, and connected objects, learning is no longer confined to time or pace. Students can engage with educational content anytime and any where fostering lifelong learning habits.

Some of the Keys ways of IOT is Transforming Higher Education

IoT in education can be understood as the process of integrating Internet of Things devices and technologies to learning settings to improve teaching and learning processes among students. It is associated with the use of interconnected equipment such as sensors, smart boards, and wearable devices to gather data and optimize the processes and provide interactive learning experiences. Finally, it assists in making the learning process effective to all participating as well as it is committed to developing collaborative, interactive, and accessible learning opportunities to students. The IoT devices in education assist students to access education facilities and practice opportunities and teachers to monitor student progress in real-time.

Smart Classrooms

The development of smart classrooms can be considered among the most common IoT effects in universities and colleges. Such areas are all concerned with smart boards, virtual reality (VR) and augmented reality (AR) that enable interactive learning. Scholars are able to engage in simulated reality, deconstruct virtual animals / investigate historical sites in their classrooms. These technologies are such that they relate the theoretical knowledge to the practical applications of the same and therefore, make learning more efficient.

Personalized Learning Experiences

Another crucial benefit of the IoT in higher education is personalized learning. IoT-based adaptive learning systems process the information on the performance of students and adjust lesson plans to suit unique needs. Students have difficulties with particular issues, the system may suggest additional resources / tutorials to assist them in addressing. This individual care will make sure that every student gets the care he or she deserves to perform. The IoT devices can give real time feedback on the performance of students and thus provide real time feedback and guidance.

Remote Learning and Collaboration

IoT plays a major role in enabling distance education. IoT powered devices, such as tablets and laptops allow students to have access to learning materials from anywhere. Students can take part in discussions / interact with teachers in real time through virtual classrooms. IoT takes global connectivity to another level by enabling students and teachers to connect with their peers' globe. This promotes cross cultural sharing / exchange and collaboration as students are given an opportunity to have a broader perspective on global issues.

Benefits of IOT in Higher Education

Some of the benefits are as given below:

i. *Improved Learning Outcomes:* These tools make learning easier, interactive and personalized, which positively affects students' academic performance.
ii. *Real-Time Data and Analytics:* It offers real time insights into students' performance which helps teachers to provide immediate feedback and support.
iii. *Increased Efficiency:* Educational institutions can save time and costs by automating administrative tasks like resource management and tracking of attendance.
iv. *Enhanced Security:* Deployment of IoT-based security systems leads to better campus safety features that prevent unauthorized access and minimize risks.
v. *Global Collaboration:* With IoT it is easy to collaborate with peer globe seamlessly, fostering a connected and inclusive learning environment.

The IoT on higher education is nothing short of revolutionary and wide-reaching. From smart classrooms to personalized learning experiences, it's changing the way both students and teachers interact with subject content. However, to fully use the essential of IoT, educational institutions must address its challenges related to cost, security and training. As IoT continues to grow, it is set to become an integral part of the forthcoming of education. This promises an environment where the students are equipped with the tools they need to thrive in a connected world.

Conclusion

IoT helps to Creating modern classrooms, fostering collaboration, and allowing for adaptive learning pathways, it helps to provide lot of innovative approaches to face the diverse needs of students. The IoT develops students' cognitive, emotional, and behavioural engagement in their learning process at the same time provides support for their personalized educational experiences and also boosts every student engagements while learning.

This research study analyse that IoT in education provides recent pedagogical practices, including in students' involvement and needs in real-time interactivity, personalized learning experiences and sudden feedback with the integration of it. This IoT gives own and personalized learning approach that takes to develop an inside and outside of the learning outcomes, and increases students' engagement, and for better retention of knowledge we are needed to follow this IoT compulsory.

References

1. Ahmad, R., & Singh, R. (2021). Role of IoT in transforming the education system. International Journal of Innovative Research in Technology, 8(3), 102–106.
2. Almalki, A., Aziz, M. A., &Alrashed, B. (2022). IoT-based smart learning environments: A comprehensive review. Education and Information Technologies, 27, 4873–4892. https://doi.org/10.1007/s10639-021-10706-4
3. Ali, R., Qazi, S., &Jalbani, A. A. (2017). IoT based student monitoring and adaptive learning system. International Journal of Computer Applications, 175(7), 10–14. https://doi.org/10.5120/ijca2017915336
4. Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., &Ayyash, M. (2015). Internet of Things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials, 17(4), 2347–2376. https://doi.org/10.1109/COMST.2015.2444095
5. Bharadwaj, R., & Singh, R. (2021). Smart learning environments using IoT in education. Education and Information Technologies, 26(1), 415–437. https://doi.org/10.1007/s10639-020-10222-3
6. Basit Bashir et al. (2025) Internet of Things (IoT) in Educational Sector,In Proceedings of the 2nd International Conference on Intelligent and Sustainable Power and Energy Systems (ISPES 2024), pages 12-21, ISBN: 978-989-758-756-6.
https://link.springer.com/chapter/10.1007/978-981-96-7222-6_16
https://www.sciencedirect.com/science/article/pii/S2665917422001143

7. Chatterjee, S., Nguyen, B., Ghosh, S. K., Bhattacharjee, K. K., & Chaudhuri, R. (2018). Adoption of IoT integrated smart home technology in India: From security and privacy perspectives. International Journal of Information Management, 43, 164–176. https://doi.org/10.1016/j.ijinfomgt.2018.07.002
8. Chen, M., Ma, Y., Li, Y., Wu, D., Zhang, Y., &Youn, C. H. (2021). Wearable 2.0: Enabling human-cloud integration in next generation healthcare systems. IEEE Communications Magazine, 58(1), 54–59. https://doi.org/10.1109/MCOM.001.1900457
9. Chopra, R., & Rajput, A. (2020). Role of Internet of Things (IoT) in education. International Journal of Advanced Science and Technology, 29(3), 13248–13253.
10. Deitje. S. Pongoh, StevanNatanaelPinangkaan, DefenEkaSaputraBawimbang, Douglas JifersonTakaendengan et al. (2024) The implementation of internet of things in education to improve the quality of learning, Syntax Admiration: p-ISSN 2722-7782 | e-ISSN 2722-5356 Vol.5,No.12.
11. Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of Educational Research, 74(1), 59–109. https://doi.org/10.3102/00346543074001059
12. Gubbi, J., Buyya, R., Marusic, S., &Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29(7), 1645–1660. https://doi.org/10.1016/j.future.2013.01.010
13. Gokulnath, C., & Kumar, V. (2020). Internet of Things: A new paradigm in modern education. Journal of Educational Technology & Online Learning, 3(2), 45–56.
14. Hsu, Y. C., &Ching, Y. H. (2013). Mobile computer-supported collaborative learning: A review of experimental research. British Journal of Educational Technology, 44(5), E111–E114. https://doi.org/10.1111/bjet.12038
15. Jayaraman, P. P., Yavari, A., Georgakopoulos, D., Morshed, A., &Zaslavsky, A. (2016). Internet of Things platform for smart learning environments. International Conference on Web Information Systems Engineering, 510–518.
    a. https://doi.org/10.1007/978-3-319-48737-3_37
16. Khaleel, F. L., Wook, T. S. M. T., Ismail, A., &Jusoh, Y. Y. (2020). Systematic review on Internet of Things in education: Benefits and challenges. Journal of Theoretical and Applied Information Technology, 98(24), 3955–3968.
17. Kay, R. H., & Leung, S. (2017). Exploring student perceptions of the use of immediate response systems in higher education. Canadian Journal of Learning and Technology, 43(1), 1–16. https://doi.org/10.21432/T28G6C
18. Khodabandelou, R., Nordin, N., & Ahmad, W. F. W. (2016). Internet of Things (IoT) applications in smart environments: A review. Advanced Science Letters, 22(10), 3223–3228.
19. Kim, H., & Kim, H. J. (2019). Smart learning environments and student engagement: A systematic review. Smart Learning Environments, 6(1), 1–13. https://doi.org/10.1186/s40561-019-0096-1

20. Liu, Y., Yu, M., & Wang, Z. (2020). The impact of smart classrooms on students' academic performance and engagement: A longitudinal case study. Interactive Learning Environments. https://doi.org/10.1080/10494820.2020.1817755
21. Madakam, S., Ramaswamy, R., &Tripathi, S. (2015). Internet of Things (IoT): A literature review. Journal of Computer and Communications, 3(5), 164–173. https://doi.org/10.4236/jcc.2015.35021
22. Madakam, S., Ramaswamy, R., &Tripathi, S. (2015). Internet of Things (IoT): A literature review. Journal of Computer and Communications, 3(5), 164–173. https://doi.org/10.4236/jcc.2015.35021
23. Papamitsiou, Z., & Economides, A. A. (2014). Learning analytics and educational data mining in practice: A systematic literature review of empirical evidence. Educational Technology & Society, 17(4), 49–64.
24. Patil, R. B., &Mhetre, V. R. (2020). Internet of Things in education: A futuristic approach. International Journal of Scientific & Technology Research, 9(1), 2903–2907.
25. Redecker, C., Punie, Y., & European Commission Joint Research Centre. (2011). The future of learning: Preparing for change. Publications Office of the European Union.
26. Sánchez, L., & Muñoz, L. (2018). Enhancing education through the Internet of Things: Applications and challenges. Sensors, 18(10), 3321. https://doi.org/10.3390/s18103321
27. Sharma, K., &Mangat, V. (2021). Exploring IoT for improved engagement in education. International Journal of Advanced Computer Science and Applications, 12(5), 123–129. https://doi.org/10.14569/IJACSA.2021.0120516
28. Saudamini Mowade (2024) Internet of Things (IOT) in Education Sector: Challenges and Opportunity, International Journal of Scientific Engineering and Research (IJSER) ISSN (Online): 2347-3878 Impact Factor (2024): 7.741.
29. Tariq, M. N., Khan, S., &Rawat, D. B. (2020). Enabling smart learning using IoT and mobile technologies: A survey. IEEE Access, 8, 207547–207570. https://doi.org/10.1109/ACCESS.2020.3037900
30. UNESCO. (2018). ICT competency framework for teachers (Version 3). UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000265721
31. Uskov, V. L., Bakken, J. P., & Pandya, J. R. (2018). Smart education and e-learning 2018. Springer.
32. Wang, C., Wang, Y., & Yu, M. (2020). The impact of classroom IoT tools on student behavior monitoring and engagement. Education and Information Technologies, 25(6), 5171–5186. https://doi.org/10.1007/s10639-020-10230-7
33. Yin, M., Lam, J., & Song, Y. (2019). Real-time emotion monitoring system using wearable sensors for online learning environments. Sensors, 19(21), 4650. https://doi.org/10.3390/s19214650
34. Zhou, Y., Piramuthu, S., & Chu, H. C. (2019). IoT and the education industry: Applications and implementation strategies. Journal of Industrial Information Integration, 13, 1–9. https://doi.org/10.1016/j.jii.2018.06.001

35. Zhou, L., Zhang, D., & Sun, J. (2019). IoT-based smart classroom for online monitoring and automatic attendance. Procedia Computer Science, 147, 642–647. https://doi.org/10.1016/j.procs.2019.01.185
36. Zhu, M., & He, W. (2020). Leveraging IoT technologies to improve engagement and learning outcomes. Education Sciences, 10(11), 305.
https://doi.org/10.3390/educsci10110305
https://indianbusinesstimes.com/public/2024/02/08/9-new-applications-of-iot-technology-in-the-education-sector
https://www.extramarks.com/blogs/schools/iot-in-education/
https://mapsted.com/en-in/blog/ways-iot-is-transforming-higher-education
https://indianbusinesstimes.com/public/2024/02/08/9-new-applications-of-iot-technology-in-the-education-sector
https://www.geeksforgeeks.org/computer-science-fundamentals/characteristics-of-internet-of-things/

FRUGAL DIGITAL INNOVATION FOR INCLUSIVE SPECIAL EDUCATION: OPERATIONALIZING THE C.A.R.E. MODEL FOR EQUITY, ACCESSIBILITY AND SCALE

Dr. M. Zaheer Ahmed
Head, Postgraduate Department of Commerce and Research
Dr. Kalaignar M. Karunanidhi Government Institute for Postgraduate Studies and Research
Karaikal, U.T. of Puducherry, India
drmzaheerahmed@gmail.com

Abstract

*This chapter explains how **low-cost digital tools** can support **inclusive special education.** It focuses on **technologies** that are **affordable** and **easy to use.** The study looks at how these tools help **learners with different needs.** It also explores how teachers can use them in **real classrooms. Case studies** show results from **India** and **other countries.** They highlight both **benefits** and **challenges**. The chapter proposes a model for **planning**, **training**, and **support**. The aim is to make education more **accessible to all.** This work links to **national** and **global education goals.** It offers **simple steps** for **policymakers, educators,** and **communities**.*

Keywords: *Frugal innovation, inclusive education, assistive technology, disability inclusion, AI in education, Universal Design for Learning (UDL), grassroots EdTech, community-driven design, policy integration, digital equity, low-cost educational tools, C.A.R.E. Model*

Introduction

In many classrooms, **inclusion** is still a **dream** rather than a **reality**. **Children with disabilities,** or those from **low-income families,** often sit at the **edge of the learning process.** They are **present in the room**, yet not **fully part** of it.

Over the last **decade, digital tools** have begun to **change** that story. Some are as simple as **text-to-speech apps** on a **phone**. Others are **low-cost devices** built by **local innovators.** They may not look **advanced**, but they **work** — and they work where **expensive imports** cannot.

Teachers in **small towns** and **rural schools** face a **daily challenge.** They juggle **large class sizes, limited training,** and **scarce resources.** When a **tool** is affordable, **easy to learn,** and **adaptable**, it stands a chance of **staying in use.** That is where **frugal digital innovation** makes its **mark**.

This **chapter** is about making that **mark** stronger. It draws on **real classrooms** in **India** and **lessons** from other **countries**. Some stories are of **success** — a **visually impaired child** reading aloud for the first time. Others are about **failure** — a **device** left **unused** because no one knew how to **maintain** it. Both **matter**.

The **purpose** is simple: show **what works, why it works,** and **how to make it last.** The **discussion** links to **Sustainable Development Goals (SDGs)**, especially the call for **inclusive** and **equitable quality education.** It also offers **practical steps** for **educators, policymakers,** and **community groups** who want to close the gap between being present in school and truly **learning.**

Conceptual Framework: The C.A.R.E. Model

Inclusive education needs more than technology. It needs systems built for adaptability, equity, and resilience. The Community-Activated Resilient EdTech (C.A.R.E.) Model addresses gaps in access for students with disabilities. It focuses on low-resource environments. The model blends **frugal innovation** (Radjou et al., 2012), **Universal Design for Learning** (Rose & Meyer, 2002), and **community-led participatory design**. Its goal is to replace exclusion with empowerment.

Identifying the Gaps

The model targets five recurring problems in inclusive education:

1. **Policy–practice divide** – India's NEP 2020 and RPWD Act exist, yet implementation is weak. Schools often lack local plans and trained teachers (UNESCO, 2023; Government of India, 2020).
2. **Poor EdTech design** – Tools are made without local input. Many are costly, language-restricted, and unsuitable for areas with weak infrastructure.
3. **Community exclusion** – Parents, learners, and local educators are rarely part of the design. Without ownership, solutions fail or get abandoned (Kameswaran & Kumar, 2018; UNICEF Kenya, 2021).
4. **System fragility** – Schools are unprepared for disruptions such as pandemics or network failures. Offline learning plans are rare (OECD, 2021; UNESCO, 2021).
5. **Feedback gap** – Grassroots innovations are not linked to policy. There is little formal reporting or advocacy (Government of India, 2022).

Rationale

The C.A.R.E. Model was built as a direct answer to these gaps.

- It links inclusive EdTech with local skills, reliable systems, and a feedback chain that reaches decision-makers.
- Students are not just users — they help design the tools they will use.
- Frugality is not about cutting corners. It is about using creativity to make solutions that last, that communities can maintain, and that stay relevant over time.

This makes inclusion not only possible but scalable and sustainable.

Defining the Model

The C.A.R.E. Model is built on four pillars.

Each pillar addresses one or more of the five systemic weaknesses.

Table 2.1 – C.A.R.E. Model: Pillars and Corresponding Gaps

C.A.R.E. Pillar	Gap Addressed
Co-creation hubs	Mismatch between EdTech tools and community needs
Activation loops	Marginalisation and fragile adoption
Resilience mechanisms	System fragility and tool abandonment
Ecosystem integration	Policy–practice gap and lack of feedback

Source: Adapted from Author's conceptual framework (2025).

Table 2.1 maps each of the four pillars of the Community-Activated Resilient EdTech (C.A.R.E.) Model to the specific systemic gap it addresses. The structure highlights the model's targeted approach to resolving persistent challenges in inclusive education by linking innovation directly to community-led needs and systemic resilience.

Pillars in Brief

1. **Co-Creation Hubs** – Spaces in schools or community centres. Students, parents, teachers, and technologists design solutions together.
2. **Activation Loops** – Peer networks that train and mentor users of inclusive technology.
3. **Resilience Mechanisms** – Repair kits, offline guides, and repair cafés to keep tools in use.
4. **Ecosystem Integration** – Policy feedback systems that channel grassroots ideas into curricula and funding.

Transition

By combining innovation, resilience, and community feedback, the C.A.R.E. Model offers a grounded path for inclusive education.

The next section presents case studies from India and Kenya that show how each pillar works in practice.

Global Validation of the C.A.R.E. Model with Real-Time Case Studies

Any model gains strength when it leaves the page and enters daily life. For the C.A.R.E. Model, that meant testing it in schools, training halls, and community spaces. Four diverse locations—India, Kenya, Brazil, and Nepal—became living laboratories.

In each, the model met different challenges: crowded classrooms in Pune, unstable internet in Nairobi's informal settlements, resource strain in São Paulo schools, and remote Himalayan villages in Nepal. The pillars of C.A.R.E. did not always look the same, but the principles—co-creation, activation, resilience, and integration—remained intact.

Case Study 1

Pune, India – Tactile Map Co-Creation Labs

One small classroom in Pune's municipal school holds a row of low tables. On them lie rough 3D-printed tactile maps—some showing India's rivers, others just a city block. These are the outcome of the Sensenet Initiative, where government teachers, engineering students, and parents of visually impaired children worked side by side.

Instead of buying imported maps at ₹800 each, they built their own for under ₹50, using open-source designs and recycled material. A teacher recalled, "*I could repair one with glue and sandpaper in under ten minutes.*"

The labs became more than production sites. They hosted workshops where students tested, rejected, and redesigned aids to match their syllabus.

Field data showed a **45% improvement in STEM concept recall** among participating learners. The case reinforced C.A.R.E.'s belief in **co-design with users** and the value of **repair-friendly tools** over polished but inaccessible imports.

Case Study 2

Nairobi, Kenya – Parent Ambassador Digital Literacy Project

In Nairobi's Mathare settlement, mothers and fathers gather under a tin roof. Each holds a small tablet. They are not the students' pupils—these parents are the learners today. UNICEF's Parent Ambassador Programme trained a first batch of 30 parents, each responsible for mentoring five to ten others in their cluster.

The training was simple: how to navigate menus, adjust accessibility settings, and troubleshoot common glitches. WhatsApp groups kept the advice flowing between sessions. Over months, the approach rippled through neighbourhoods.

Abandonment rates for donated devices dropped **by 65%**, and the district education board updated procurement rules to favour devices rated highly in parent reviews. For C.A.R.E., this was proof that **activation loops** can extend far beyond the school gate, and that **bottom-up influence** can alter policy.

Case Study 3

São Paulo, Brazil – Municipal Repair Cafés in Schools

A broken projector used to mean months of waiting and a budget request. In São Paulo's pilot repair cafés, it became a Saturday project for students, teachers, and local tradespeople.

Workshops in basic electronics and mechanics turned into quarterly "fix-it" days. Students proudly led sessions on replacing cables, soldering connectors, and repurposing old casings. Municipal grants helped schools set up benches and toolkits. Within the first year, **three-quarters of previously discarded devices were restored.** E-waste reduced noticeably, and annual ICT maintenance costs dropped. The resilience pillar of C.A.R.E. came alive here—not through theory, but through screwdrivers, circuit testers, and shared problem-solving.

Case Study 4

Rural Nepal – Feedback-Driven Procurement

In one mountain district of Nepal, Save the Children and UNESCO tried a different tactic: before buying technology, they tested it. Parents, teachers, and students with disabilities received sample devices for several weeks.

The feedback was gathered via SMS and handwritten forms. Complaints about language barriers and offline access led suppliers to modify software before any bulk purchase. Provincial guidelines now require this "community review" stage before procurement.

Usability ratings rose by 38% in the following year. This example strengthened C.A.R.E.'s **ecosystem integration** pillar—showing how grassroots feedback can directly shape official policy.

Synthesis Table – Model Validation Matrix

Table 3.1: Model Validation Matrix for the C.A.R.E. Framework

C.A.R.E. Pillar	Country & Case Example	Validation Outcome
Co-Creation Hubs	India (Tactile Map Labs), Nepal (Review Forums)	Localised design, greater accessibility, user empowerment
Activation Loops	Kenya (Parent Ambassador Programme)	Viral peer learning, reduced abandonment, scalable adoption
Resilience Mechanisms	India & Brazil (Repair Training, Municipal Repair Cafés)	Cost savings, extended tool life, community self-reliance
Ecosystem Integration	Kenya & Nepal (Policy-Linked Feedback Loops)	Procurement reform, formalised grassroots input

Source: Author's field synthesis based on documented programmes (2018–2023).

This table maps the four pillars of the C.A.R.E. Model to real-world case studies across India, Kenya, Brazil, and Nepal, showing how each pillar addresses specific challenges in inclusive education and validates the framework's scalability and effectiveness.

Across continents, the C.A.R.E. Model adapted to contrasting realities—urban density in Kenya, rural isolation in Nepal, resource gaps in India, and municipal bureaucracy in Brazil.

What connected these places was the shift from **passive receipt of technology to active shaping of it.** When tools were co-created, maintained locally, and linked to decision-making structures, they lasted longer and reached more learners. The global trials confirm that C.A.R.E. is not only workable in theory. It is a living method for making inclusive education **practical, affordable, and resilient.**

Implementation Roadmap of the C.A.R.E. Model

Purpose and Scope

Rolling out the C.A.R.E. Model is not about dropping in fancy gadgets and hoping for the best. It's about building trust, knowing the ground reality, and making sure the community feels it is their project.

This roadmap works for small rural schools, busy urban classrooms, and even after-school learning centres. It is meant for decision-makers, teachers, NGOs, and local volunteers who are willing to take it step by step.

Phase One – Knowing What's Already There

Goal:

Find out what strengths you already have and what's missing.

How to do it:

- Call a community meeting—parents, students, local leaders, and teachers.
- Walk through the school or centre, listing available tools and materials.
- Listen to stories of what's worked before and what failed.

What you get:

A simple "ready/not ready" picture and a map of both assets and obstacles.

Phase Two – Setting Up the Co-Creation Hub

Goal:

Turn ideas into low-cost tools that fit local needs.

How to do it:

- Use an empty classroom, library corner, or even a community hall.
- Bring in open-source designs and basic toolkits.
- Run short design challenges—invite students, parents, and local tinkerers to join.

What you get:

At least three working prototypes that students helped design.

Phase Three – Starting the Activation Loops

Goal

Spread know-how without waiting for experts.

How to do it:

- Pick a few "digital ambassadors" from the community—people others trust.
- Let them run small group sessions at homes, markets, or playgrounds.
- Share step-by-step guides in the local language, with pictures.

What you get:

More people using the tools, less dependency on outside trainers.

Phase Four – Keeping It Running (Resilience Mechanisms)

Goal:

Avoid the "dead gadget" problem.

How to do it:

- Organise repair days—invite anyone handy with tools.
- Keep a small stock of spares and printed fix-it sheets.
- Teach students basic maintenance as part of lessons.

What you get:

Fewer breakdowns, faster fixes, and pride in self-reliance.

Phase Five – Closing the Loop with Policy Makers

Goal:

Make sure grassroots voices shape the bigger system.

How to do it:

- Record short video testimonials from parents and students.
- Share repair and usage stats with local education officers.
- Push for procurement and curriculum updates that match local needs.

What you get:

Stronger policies and funding that reflect real classroom realities.

Quick Implementation Checklist

Table 4.2: C.A.R.E. Model Implementation Checklist

Step	Status	Who's Involved	What You'll Have
Community mapping done	☐	Teachers, NGOs	Maps, survey notes
Hub set up	☐	School leaders, parents	Space, design logs
Activation loops running	☐	Ambassadors, students	Training records
Repair system in place	☐	Teachers, technicians	Manuals, toolkits
Policy link active	☐	Officials, community reps	Dashboards, stories

Source: Author's field synthesis (2025)

The roadmap gives a clear plan for inclusive digital education.

- It is scalable.
- It is low-cost.
- It is driven by the community.
- Areas can use the C.A.R.E. Model without buying costly systems.
- They do not need outside consultants.
- Each phase includes equity.
- Each phase includes frugality.
- Each phase includes participation.
- The plan changes inclusion from a fixed policy goal to a living system.
- The system can run on its own.

The next section shows how stakeholders can check results. It explains how they can use participatory evaluation. It guides them to improve the model over time.

Monitoring, Evaluation, and Adaptive Learning Framework

Purpose and Approach

The C.A.R.E. Model needs constant review.

- It must improve based on evidence.
- It must involve all stakeholders.

This section presents a Monitoring, Evaluation, and Learning (MEL) approach.

- It measures technical results.
- It also measures social changes created by the model.
- The method uses both numbers and stories.
- It aims for a human-centred way to assess inclusion and innovation.

Core Evaluation Dimensions

The following table lists the main areas to check when seeing if the C.A.R.E. Model is working well. It turns the model's ideas into things you can measure — from how many learners actually use the tools to whether local policy has changed.

Table 5.1: C.A.R.E. Model Evaluation Dimensions

Dimension	Focus Area	Example Metrics
Accessibility	Reach and usability for learners with disabilities	% of enrolled learners using tools
Engagement	Participation of stakeholders	Number of co-design sessions; peer-training cycles
Sustainability	Long-term viability and local ownership	% of repairs done locally; drop-off rates
Policy Influence	Systemic integration and scale	Number of policy changes; citations in reports

Source: Author's synthesis using principles from participatory monitoring, SDG 4 frameworks, and frugal innovation studies (UNESCO 2021; OECD 2019; Kameswaran & Kumar 2018).

These points give a simple way to track both the human and system sides of the model. They help schools, communities, and policymakers see what is improving and where changes are needed.

Data Collection Methods

The MEL plan uses mixed tools.

Quantitative

- Logs for attendance, usage, and device uptime.
- Surveys with rating scales for usability and satisfaction.

Qualitative:

- Focus group talks with students, parents, and teachers.
- Interviews with school leaders and policymakers.
- Case diaries from digital ambassadors and repair facilitators.

Participatory Monitoring Strategies

Community-led checks are key.

1. **Learning Circles:** Parents and students meet monthly to share views.
2. **Digital Storytelling:** Use videos or infographics to show successes or failures.
3. **Scorecards:** Display visual dashboards in schools for progress tracking.
4. **Feedback Tokens:** Use tactile or graphic tokens for feedback from learners with impairments.

Adaptive Learning Loops

The model changes with feedback.

Trigger Points and Actions:

- **Tool abandonment rises:** Run new peer-training sessions.
- **Repair backlog over 20%:** Hold a fixathon.
- **Low user satisfaction**: Redesign tools in co-creation labs.
- **Policy inaction:** Share evidence stories with decision-makers.

Linking to National and Global Indicators

The MEL aligns with:

- Shaala Siddhi (India's school evaluation tool).
- NEP 2020 inclusion benchmarks.

SDG 4 targets:

- 4.a (inclusive facilities)
- 4.c (teacher training)
- (removing inequities).

A strong MEL system turns the C.A.R.E. Model into a growing ecosystem. It uses community voices and participatory data. It makes inclusion real, flexible, and scalable.

The next section gives final policy steps based on the model's field results and theory.

Final Reflections and Policy Recommendations

Reflections on Model Development

The C.A.R.E. Model was not born in a conference room. It came from the ground — from classrooms, small workshops, and community halls. The aim was simple: build inclusion with the people who live it every day. In India, a teacher used it to help a child read for the first time. In Kenya, parents taught each other to fix devices instead of throwing them away. In Brazil and Nepal, the model shaped new ways of learning without huge budgets. One truth stood out. Communities already have the strength to keep tools alive. What they lack is a seat at the table. The real shift was not the arrival of new technology — it was the sharing of control, trust, and responsibility. Inclusion became less of a target on paper and more of a daily habit.

Policy Recommendations

1. Put Co-Creation Hubs in Every District

- Make space in schools or libraries where students, teachers, and local makers can create.
- Budget for simple tools and materials.
- Invite NGOs and colleges to join the design process.

2. Recognise the "Digital Ambassadors"

- Train students, parents, and local volunteers to guide others.
- Give them a name badge, a certificate, and a role in digital literacy programs.

3. Make Repair Part of the Scorecard

- Judge schools not only on grades, but also on how well they care for their tools.
- Give small funds to run repair days or "fix-it" clubs.

4. Keep the Feedback Flowing

- Post clear progress charts in schools.
- Show what's working and what's not.
- Feed these results into lesson plans, device purchases, and teacher workshops.

5. Use Flexible Monitoring Tools

- Link state or district school reviews with the C.A.R.E. metrics.
- Let each region adapt the process to its own needs.

6. Support Grassroots Innovation

- Offer small grants to anyone with a low-cost idea for inclusive learning.
- Make sure new tools work in local languages and offline.

Closing Thought

Inclusion is no longer a question of why. It is a question of how.

The C.A.R.E. Model is one answer — built in classrooms, tested in communities, and shaped by real voices.

If we listen, adapt, and keep the work close to the ground, the gap between policy and practice can close.

And when that happens, no child will be left sitting on the edge of the room.

References

1. Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2017). Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning,* 17(3), 56–72. https://doi.org/10.14434/josotl.v17i3.22102
2. Den Hollander, M. C., Bakker, C. A., & Hultink, E. J. (2017). Product design in a circular economy: Development of a typology of key concepts and terms. *Journal of Industrial Ecology,* 21(3), 517–525. https://doi.org/10.1111/jiec.12610
3. Government of India. (2020). *National Education Policy 2020.* Ministry of Education. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
4. Government of India. (2022). *DIKSHA: Digital Infrastructure for Knowledge Sharing – Annual Report 2021–22.* Ministry of Education. https://diksha.gov.in/resources
5. Kameswaran, V., & Kumar, N. (2018). Engaging with disability: Participatory design and information technology in Indian schools for blind students. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Paper No. 237). ACM. https://doi.org/10.1145/3173574.3173811
6. OECD. (2019). *OECD skills outlook 2019: Thriving in a digital world. OECD Publishing.* https://doi.org/10.1787/df80bc12-en
7. OECD. (2021). *The state of global education: 18 months into the pandemic.* OECD Publishing. https://www.oecd.org/education/state-of-education-2021.htm
8. Patel, A., & Kumar, S. (2023). Localizing STEM education for blind students in India: A frugal tactile innovation framework. *International Journal of Inclusive Education,* 27(5), 433–448. https://doi.org/10.1080/13603116.2021.1987889
9. Radjou, N., Prabhu, J., & Ahuja, S. (2012). *Jugaad innovation: Think frugal, be flexible, generate breakthrough growth.* Jossey-Bass.

10. Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning.* ASCD.
11. Save the Children. (2020). *Building digital inclusion in rural Nepal: Pilot findings and community review report.* Save the Children Nepal.
12. Tempelaar, D., & Plomp, T. (2021). Scaling parent-led digital literacy: Evidence from urban Kenya. *International Review of Education,* 67(3), 425–444. https://doi.org/10.1007/s11159-021-09904-0
13. UNESCO. (2021). *Reaching out to all learners: Policy and practice in digital education.* https://unesdoc.unesco.org/ark:/48223/pf0000377231
14. UNESCO. (2023). *Global Education Monitoring Report 2023: Technology in education – A tool on whose terms?* https://www.unesco.org/gem-report/en/2023
15. UNICEF Kenya. (2021). Parent *Ambassador Model for Digital Inclusion in Kenya.* Nairobi: UNICEF. https://www.unicef.org/kenya/reports/parent-ambassador-model
16. World Bank. (2022). *EdTech in low-income countries: A frugal framework.* https://documents.worldbank.org/en/publication/documents-reports/documentdetail/280121638551965720

EMERGING TECHNOLOGIES: CONCEPT, MECHANISMS AND APPLICATIONS OF ARTIFICIAL INTELLIGENCE, VIRTUAL REALITY/AUGMENTED REALITY AND SMART CLASSROOM FOR PERSONS WITH DISABILITIES

Dr. D. Revathi
Lecturer, Department of Special Education and Research
National Institute for Empowerment of Persons with Visual Disabilities (Divyangjan)
Dehradun, Uttarakhand State
reva.duraisamy12@gmail.com

Sh. Kevin John Varghese
M.Ed Scholar, National Institute for Empowerment of Persons with
Multiple Disabilities (Divyangjan), Chennai, Tamil Nadu State
kevin.j.varghese159@gmail.com

Abstract

Technological advances have rapidly increased in all fields, including education and social science research. This technology offers innovative solutions that develop learning and communication for all children. This chapter focuses on exploring emerging technologies and innovative aspects, such as artificial intelligence, virtual/augmented reality, and smart classrooms, and their impact on children with special needs. This chapter provides a definition, core mechanisms, and evidence-based applications designed to enhance accessibility, learning, social integration, and independence. It provides a clear concept for educators, researchers, and policymakers with insights into leveraging these tools for independent living skills and the inclusion of children with special needs.

Keywords: *Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Smart classrooms, Assistive Technology*

Introduction

Children with disabilities face challenges in major activities such as accessing education, employment, and inclusion. Intervention/training and support help children develop the necessary skills to face challenges to some extent. A limitation is that personalized learning is not possible, and assistance or supervision to support or monitor children with disabilities is unavailable. A paradigm shift is underway, driven by the integration of the potential of Artificial Intelligence (AI) and immersive technologies (VR/AR) to support children with disabilities. Technology integration has created these kinds of support requirements for children with special needs, a rather traditional approach that is often unable to bridge the gap of tailored interventions to help them reach their full potential.

1. Artificial intelligence offers unprecedented personalization by adapting content, pace, and instructional strategies to individual needs, as well as prediction by analyzing data from student interactions, which results in timely interventions, such

as recommending additional support or alternative teaching methods. And the adaptation of learning environments in real time

2. VR/AR creates novel experiential and spatial contexts for learning and interaction; for example, VR-based social skills training allows individuals to practice conversations and interpret social cues in a risk-free, repeatable environment (Parsons & Cobb, 2011).
3. The trend is smart classrooms and is notable for advanced learning classrooms. Internet-enabled smart classrooms facilitate learning for persons with disabilities, meaning truly inclusive and accessible education.

This chapter focuses on exploring the convergence of emerging technologies and innovative aspects such as artificial intelligence, virtual reality/augmented reality, smart classrooms, and their impact on children with disabilities. The chapter's objective is to provide clear concepts, mechanisms, and applications for educators, researchers, and policymakers, as well as insights into integrating these tools for independent living skills and the inclusion of children with special needs.

Artificial Intelligence (AI) - Concept, Mechanisms and Applications

Concept:

Artificial intelligence is computerized human-attributed action that has gained increasing focus in the last 30 years and has become the top after the COVID - 19 pandemic (Mckee et al., 2023). Artificial intelligence (AI) is when computers can do things that are usually done by people. AI encompasses learning, which is acquiring information and reasoning to reach conclusions, solving problems, perceiving or understanding sensory input and language, and making decisions (Wikipedia, 2024).

Mechanism and Applications

Artificial intelligence innovations are broadly classified into natural language processing, computer vision, and intelligent tutoring systems and play various roles as follows:

1. Data input: Data input is the source from which data are collected or gathered through various sensors, such as cameras, microphones, wearable gadgets, interaction logs, feedback, and user profiles. Artificial intelligence is useful for the rehabilitation of persons with specific disabilities. Individuals with visual impairment are limited to information through sensory channels. The use of Artificial Intelligence can support and guide persons with visual impairment.
2. Processing information: AI Machine learning models were used to analyze the data. The data can be anything, such as objects and scenes.. Another AI innovation is the processing of natural language, where computers can understand and generate human language. Persons with disabilities, such as motor, visual, and learning disabilities, require speech-to-text transcription or vice versa.
3. Data output: Data output is used to obtain information in an accessible format. AI can provide information in an accessible format about an image or object of anything.

Seeing AI applications by Microsoft can help persons with visual impairment understand any description of persons, text, and objects using computer vision, tailoring information delivery to the user's context (Microsoft, 2023).

4. Adaptation: Users are dynamic in nature and require adaptation or adjustment in the system according to individual differences. For example, the difficulty level can be low or high, and the complexity can be high or low.
5. Personalization: Users are preferred for selection; artificial intelligence has the option of taking feedback and improvising according to users. There comes a system of personalisation that becomes the advantage of Artificial Intelligence.

For Visually Impaired

1. AI-powered Smartphone apps are Seeing AI (Microsoft. (2017), Google Lookout (Farra, D, 2024) and Goodmaps Explore
2. Screen readers are called text-to-speech conversion, which will be beneficial for persons with visual and communication disorders. Screen reading software, such as JAWS and NVDA, offers options for adjusting the volume, pitch, and speed of reading.
3. AI chatbots can answer questions, repeat instructions and offer individualised instruction, viz., Google's Read Along

For Hearing Impairment and Communication Disorders

1. Children with hearing impairment (Deaf or hard of hearing) are provided with captions or sign language to text by using natural language processing, e.g., Google Live Transcribe
2. Interpretation of Visual cues such as body language, facial expression and lip reading through AR glasses
3. Auditory training apps use AI-driven phoneme discrimination tools

For Intellectual Developmental Disabilities and Other Disabilities

1. Step by step instructions with visual instructions of real-world objects or environment for task completion.
2. Voice recognition software (speech-to-text conversion, text-to-speech conversion) used for teaching and learning of children with learning disabilities or motor disabilities, viz., Dragon Naturally Speaking, Google voice typing.
3. Alternative and augmentative communication that helps children with limited speech or nonverbal communication. AAC includes sign language and various communication boards, both manual and electronic, used by individuals with impaired oral motor skills. These communication apps can write words, phrases and even sentences. viz., Proloquo2Go, Avaz

Artificial intelligence enables more personalized learning experiences depending on individual needs, called intelligent tutoring. AI facilitates communication and content adaptation and offers pace to each child's ability. For targeted intervention, the advanced technology of AI-driven tools is supportive of children with cognitive and sensory disabilities, where the design of algorithms reflects the acceptance and diversity of human existence.

Virtual and Augmented Reality (VR/AR)

Concept

In recent times, virtual reality (VR) and augmented reality (AR) have increased the attention of educators to present in teaching-learning environments. Children with disabilities required a real immersive opportunity to enhance their skills. Emerging technologies such as AR and VR create such immersive learning according to the individual needs. The training using AR and VR helps better understanding (Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). The two technologies Virtual reality (VR) is immersive technology, which means it engages user senses to simulate the alternative environment, like a 3D or computer-generated environment, whereasaugmented reality (AR) does not replace physical surroundings but provides digital information in the form of images, text, and animation, which creates an immersive experience through this blending of physical and digital elements.

Mechanism and Applications

1. Virtual Reality supports children in experiencing and enacting environments that are safe, engaging, and manageable. In addition, a significant factor is that learners who may become overwhelmed in real-world situations due to display blocking external light can help persons with disabilities maintain their focus. The same task in a real situation may have many obstacles to learn, but it is possible because of this VR/AR technology.
2. Processing: VR/AR immersive technology helps the persons with disabilities to understand the real-time difficult situation of a 3D environment and sensor fusion
3. Interaction: The individual user's interaction in the form of gestures, voice, or feedback is considered. It supports training individuals with disabilities on a task from a zero level.
4. Adaptability: The adaptability and custom ability of VR/AR tools can allow educators and other caregivers to modify the instruction to participants' learning profiles, a step ahead in forwarding personalized special education.

For Visually Challenged

1. Through the mechanisms of virtual reality/augmented reality, visually impaired persons can get immersive instructions through audio, and then sensory-based feedback promotes independent daily living skills such as crossing a street or using public transport.

2. Virtual reality eye-tracking and gesture recognition systems are the supports that provide an adjusted experience to the persons with visual challenges.
3. VR support to enhance the independent living of persons with visual impairments by developing spatial ability and navigation is another difficult area for persons with visual impairments.

For Hearing Challenged

1. VR/AR uses sensory alerts and instructions and according to Ghali et al, 2012 studied haptic VR improves mobility orientation among the visually impaired persons
2. EarVR uses vibrations on the ear to identify the direction of important sounds creating an immersive environment for persons with hearing impaired (Mirzaei, Kan & Kaufmann, 2020). visual cues using VR technology can enhance the accessibility of people with hearing impairment (Serafin et al, 2023). For example, children with hearing impairments may benefit from visual cues in AR-augmented stories. However, those with intellectual disabilities can study cause-and-effect relationships through gamified Virtual Reality tasks.

For Intellectual Developmental Disabilities

1. VR/AR provides a hands-on learning, experiential learning to enhance the skills such as hygiene, safety skills in a virtual simulated environment. this can enhance independence and self-confidence without reality risks
2. Children with intellectual developmental disabilities can enact social interactions or emotional recognition and daily living routines or acquire safety guidelines through virtual replications, which is supportive and can minimize the level of anxiety and develop social responsiveness over time (Newbutt et al, 2020). Augmented Reality, on the other hand, addresses and covers digital information in the natural world, improving the learner's environment and pace instead of replacing it. This is beneficial and can assist children with attention deficits or processing disorders in sustaining focus on relevant aspects of a learning task.

Positive educational outcomes have benefited VR/AR, which lies not only in the instructional content delivery but also in the hands-on nature of learning for meaningful, inclusive education strategies. Consequently, these technologies have validated and committed to developing social skills, cognitive flexibility, and even motor planning, including for learners with disabilities. However, accessibility, affordability, and ethical considerations persistently pose various challenges to the implementation of these technologies, particularly in educational settings.

Smart Classrooms: Concept, Mechanisms and Applications

Concept

The current scenario in the digital era conveys that the idea of a "smart classroom" has a great lasting effect on students with disabilities in an inclusive classroom. Primarily, a smart classroom is an environment that offers technology to assist each learner, especially children with special needs, thoughtfully. Among all these technological aspects and components that make it possible to access a dependable Internet, the most important is the Internet itself. The Smart classroom inbuilt internet provides teachers and students access to an infinite variety of educational material ranging from visual clue applications and interactive lessons to assistive technologies tailored for disabled students.

Mechanism and Applications

Flexibility and adaptation: Smart classrooms offer flexibility in learning and provide support for students with disabilities to adapt the level of their difficulty and activity mode to increase students' performance in real time.

Personalized: Google Classroom and Microsoft Teams can be adapted to the ability and speed of each learner. Instructions can be delivered in a form suitable or applicable to the learner's interest using audio, visual, or interactive methods by teachers, and learners can access lessons as many times as needed. Smart Classroom platforms or school digital apps enable the making of available updates, homework, video instructions, and feedback directly to families. Such collaboration will help reinforce consistency across schools and homes, which is critical for children who depend on routine and consistency.

For the Visually Impaired, accessibility features accompanied by smart classroom technology promote learning without barriers, adapt to the level of children with visual disabilities, and create flexibility in learning.

For hearing impairment, captioned videos and real-time transcripts are used, whereas visually impaired students are helped by screen readers and auditory-based learning materials. Such resources are provided over the web; without connectivity, they cannot be utilized at all.

For Intellectual Developmental Disabilities

Children with autism, ADHD, or learning disabilities probably need repetition and a framework. Smart classrooms reinforce communication between home and school.

Other examples of software and technological solutions include the Magic Room Software System, which helps alter classrooms into immersive, multi-sensory environments using various interactive visuals, sounds, and activities tailored for learners with conditions such as Severe Learning Difficulties (SLD) and autism.

Smart Assistive Learning Technology (SALT) is another system of profiles for learners based on disability type and customized e-learning resources accordingly (Al-Hudhud & Chor, 2017).

Dreambox Learning is a math platform that uses an intelligent adaptive learning system that can evaluate and interpret interactions of students' responses and patterns of behaviour, then adjust the content to tailor their learning. This ongoing and continuous assessment ensures students remain within their optimal learning zone, promoting engagement DreamBox Learning, 2024)

An augmentative and alternative communication (AAC) app Proloquo2Go is used by children with neurodevelopmental disorders who are non-verbal to communicate their daily needs through adapted communication boards.

Smart classrooms provide equal access to all learning, even for children at home. However, accessing the devices is unreliable for students of socially disadvantaged groups (Moore, Vitale, & Stawinoga, 2018).

Conclusion

Emerging technologies and innovations are restructuring the education of children with special needs. Technologies and AI create inclusivity; therefore, it is important to consider the need for an approach to bring persons with disabilities much closer to overcoming marginalization. By harnessing the power of Artificial Intelligence, VR/AR, and smart classrooms, more inclusive, personalized, and empowering experiences can be created. It is promising evidence presenting the long-term efficacy but it is still evolving. However, successful implementation requires ongoing collaboration, training, and consideration of accessibility issues. Informed consent frameworks under Ethical Considerations can be significantly important in the empowerment and rehabilitation of persons with disabilities. The teacher educators must gain knowledge and training as it holds the promise of breaking down barriers and unlocking new possibilities for every child.

References

1. Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Social Sciences & Humanities Open, 8*(1), 100532. https://doi.org/10.1016/j.ssaho.2023.100532
2. DreamBox Learning. (2024, August 10). DreamBox Math: Continuous assessment & adaptivity. DreamBox Learning Help Center. Retrieved August 13, 2025, from https://dreamboxlearning.zendesk.com/hc/en-us/articles/27281596241043-DreamBox-Math-Continuous-Assessment-Adaptivity
3. Freedom Scientific. (n.d.). *JAWS® – Screen reader*. https://www.freedomscientific.com/products/software/jaws/
4. Farra, D. (2024). Google’s Lookout: Prioritizing beauty and accessibility in app design. *Google Design*. Retrieved from https://design.google/library/google-lookout-design-accessibility
5. Ghali, Neveen & Soliman, Omar S. & El-Bendary, Nashwa & Nassef, Tamer & Abdelghafar, Sara & Elbarawy, Yomna & Hassanien, Aboul Ella. (2012). Virtual Reality Technology for Blind and Visual Impaired People: Reviews and Recent Advances. 10.1007/978-3-642-23363-0_15.
6. Lohse, K. R., Hilderman, C. G., Cheung, K. L., Tatla, S., & Van der Loos, H. F. (2014). Virtual reality therapy for adults post-stroke: a systematic review and meta-analysis exploring virtual environments and commercial games in therapy. *PloS one*, *9*(3), e93318. https://doi.org/10.1371/journal.pone.0093318

7. McKee, M., Rosenbacke, R., & Stuckler, D. (2024). The power of artificial intelligence for managing pandemics: a primer for public health professionals. The International Journal of Health Planning and Management, 40(1), 257-270. https://doi.org/10.1002/hpm.3864
8. Microsoft. (2017, 2023). Seeing AI. Retrieved from https://www.microsoft.com/en-us/ai/seeing-ai
9. Mirzaei, M., Kan, P., & Kaufmann, H. (2020). *EarVR: Using Ear Haptics in Virtual Reality for Deaf and Hard-of-Hearing People.* IEEE Transactions on Visualization and Computer Graphics, 26(05), 2084–2093.
10. Moore, R., Vitale, D., & Stawinoga, N. (2018). *The digital divide and educational equity: A look at students with very limited access to electronic devices at home*. ACT Research & Center for Equity in Learning. https://equityinlearning.act.org
11. NV Access. (n.d.). *NVDA screen reader*. https://www.nvaccess.org/
12. Newbutt N, Bradley R, Conley I. Using Virtual Reality Head-Mounted Displays in Schools with Autistic Children: Views, Experiences, and Future Directions. Cyberpsychol Behav Soc Netw. 2020 Jan;23(1):23-33. doi: 10.1089/cyber.2019.0206. Epub 2019 Sep 6. PMID: 31502866.
13. Parsons, S., & Cobb, S. (2011). State-of-the-art of virtual reality technologies for children on the autism spectrum. *European Journal of Special Needs Education*, *26*(3), 355–366. https://doi.org/10.1080/08856257.2011.593831
14. Serafin, S., Adjorlu, A., & Percy-Smith, L. M. (2023). A Review of Virtual Reality for Individuals with Hearing Impairments. *Multimodal Technologies and Interaction*, *7*(4), 36. https://doi.org/10.3390/mti7040036
15. Wikipedia. (2024). Artificial intelligence. In *Wikipedia, The Free Encyclopedia*. Retrieved June 2024, from https://en.wikipedia.org/wiki/Artificial_intelligence

BRIDGING THE DIGITAL DIVIDE IN SPECIAL EDUCATION: CONTEXTUAL STRATEGIES FOR INCLUSIVE TECHNOLOGY INTEGRATION

S. Arul Dayanand
Dr. T. R. Paarivendhar Multidisciplinary Research Centre for Indigenous Language Studies
Revitalisation, and Computational Resources
Department of Language, Culture and Society,
Faculty of Engineering and Technology,
SRM Institute of Science and Technology, TN, India
aruldays@srmist.edu.in

M. Uma Devi
Department of Computing Technologies,
Faculty of Engineering and Technology,
SRM Institute of Science and Technology, TN, India.
umadevim@srmist.edu.in

Abstract

This chapter explores methods to implement technology across different educational environments. The text focuses on assistive tools together with emerging trends. The analysis in this chapter examines three dimensions of the digital divide which include access gaps and usage gaps and quality gaps. The chapter explains the difficulties that urban areas and rural regions and low-income communities face. The discussion covers practical technology integration. The chapter demonstrates how assistive devices and mobile outreach programs improve accessibility and digital literacy for elderly populations. The chapter demonstrates how modern trends address different learning requirements through specific examples. The chapter discusses two educational approaches which are artificial intelligence for personalized learning and open educational resources (OER). Three case studies demonstrate how these strategies work in practice. The case studies present an AI-powered tutoring system in European schools together with a virtual reality program in a U.S. district and a rural digital literacy initiative in India. The successful implementations face ongoing difficulties because of funding constraints and teacher readiness and physical infrastructure limitations. The future research agenda should concentrate on policy advocacy and culturally responsive design and teacher development and research and local context-sensitive strategies. The chapter demonstrates that digital divide bridging needs integrated approaches which understand local requirements. The achievement of inclusive outcomes depends heavily on collaborative involvement from all stakeholders.

Keywords: *digital divide, special education technology, assistive technology, inclusive education, AI in education, digital literacy*

Introduction

The digital divide poses a significant challenge to special education. It affects the educational opportunities of diverse populations, particularly students with disabilities. Disparities in access to Information and Communication Technologies (ICT) are a key issue (Rani et al., 2025). These disparities extend beyond access to devices and connectivity. They are closely tied to socioeconomic status, geographic location, disability type, and institutional capacity (Werfhorst et al., 2022). Betlej and Danileviča highlighted these complexities. They emphasized the importance of integrating learning technologies into the curriculum. This integration is crucial for creating accessible e-learning environments for individuals with such disabilities. Students with disabilities often face additional challenges. These barriers are not as evident in typically developing peers. This situation calls for a multifaceted approach to digital inclusion (Seale, 2022).

Foundational access to high-speed Internet and appropriate devices is essential to achieve genuine digital inclusion in special education. This must be complemented by a holistic ecosystem (Bong & Chen, 2021). This ecosystem should incorporate assistive technologies, specialized digital literacy curricula, and adaptive learning frameworks. Seale's analysis shows how the pandemic increased awareness of digital exclusion. This study emphasizes the need for sustained changes to digitally inclusive practices beyond the immediate crisis. Efforts to improve faculty competence in digital accessibility and inclusive education are thus critical. Bong and Chen argue that both academic and administrative staff play crucial roles in creating accessible learning environments. This comprehensive ecosystem must accommodate diverse learning needs and abilities in special education (McGinty, 2020).

The implementation of technology in special education depends heavily on contextual elements which affect how students access and use technology (Hornby, 2015). The factors that influence this process include institutional support together with regulatory frameworks. McGinty stresses the requirement for digital learning materials that are accessible to all students. The materials enable people with disabilities to participate actively in both physical and virtual learning spaces. Hornby stresses that inclusive education philosophies need to be integrated with disability interventions. The approach enables the development of successful educational strategies. The digital divide functions as a fundamental factor which enhance technology integration in special education according to this chapter. The research-based strategies work to create more inclusive digital learning environments (Simkova et al., 2024).

Understanding the Digital Divide in Special Education

Dimensions of the Divide

Research has identified three core dimensions of the digital divide in special education: access, usage and quality gaps. The main issue with access gaps is the physical availability of connectivity and suitable devices. Many students with intellectual disabilities face significant challenges at their homes. The lack of high-speed Internet and suitable hardware to support their specific learning needs and assistive technology (Azubuike et al., 2021) is a common problem for these students. The financial burden of specialized devices further exacerbates these challenges. Families struggle to afford resources such as adaptive keyboards, eyetracking systems, and communication devices.

Students encounter usage gaps because they have access to technology yet lack the necessary skills or support to use it effectively. Students with autism spectrum disorders may have access to devices. The social and communication requirements of collaborative online platforms create difficulties for students with autism spectrum disorders (Qi et al., 2015). Students with ADHD experience difficulties when using complex digital interfaces. The combination of screen time duration and difficulty staying focused creates challenges for these students (Alkhoui, 2021). The identified gaps demonstrate the requirement for specific training and support programs.

Quality gaps describe the difference between digital resources and theis suitability and flexibility for educational purposes. These are especially important in the ccontext of special education. One-size-fits-all solutions often fail to meet the unique requirements of students with disabilities. These students may benefit from digital tools that accommodate different learning styles, sensory preferences and cognitive abilities (Barlow, 2021). Current mainstream educational technologies frequently lack the necessary flexibility. This results in digital experiences that are either inaccessible or ineffective for students with varying disabilities (Adeleye et al., 2024). Closing these quality gaps is essential for fostering an inclusive digital learning environment in the field of special education. This ensures that all students can leverage technology for meaningful educational outcomes.

Contextual Variations

The digital divide demonstrates various characteristics between urban and rural areas and low-income settings when it comes to special education. Each environment creates different obstacles which prevent equal technology access. The infrastructure in urban schools typically meets the required standards. The preparedness of teachers and individualized support for students with disabilities remains a significant gap in urban schools (Mathrani et al., 2021). The evidence shows that professional development initiatives need to be specifically designed for this purpose. These initiatives help educators develop skills to effectively use technology in various classroom settings.

Conversely, rural areas frequently grapple with technological connectivity and a shortage of resources. This has resulted in a greater need for innovative solutions, such as mobile digital labs tailored for rural learners (Wen & Tian, 2024). Mobile units can help bridge access gaps. They can bring the necessary technology and training directly to underserved areas. This enhances the learning opportunities for students with disabilities. Enhancing infrastructure in rural settings is essential for reducing the digital divide.

The availability of devices and professional development budgets remains a challenge for low-income districts. This exacerbates the divide. The lack of devices prevents students from accessing digital learning resources. The resources could otherwise support educational growth (Li, 2024). The relationship between economic resources and technological access shows that these communities tend to be ignored. The situation requires immediate policy intervention to address these existing disparities.

Overall, addressing the digital divide in special education requires a multifaceted approach. It must consider the context-specific challenges faced by urban, rural, and low-income populations. Solutions must encompass infrastructure improvements. They should also include targeted training and support. These efforts aim to empower educators and students to harness the potential of technology for enhanced learning outcomes.

Tools for Bridging the Digital Divide

Assistive Technologies

Assistive tools have proven effective in enhancing accessibility for students with diverse needs. Speech-to-text software, augmentative and alternative communication (AAC) devices, and adaptive keyboards are examples of such tools. AAC devices empower nonverbal learners to participate in classroom dialogue. Screen readers enable visually impaired students to independently access digital contents (Muazu et al., 2024). These technologies are essential for promoting inclusivity. They provide students with disabilities with the resources necessary for successful educational experiences.

Collaborative Platforms

Cloud-based collaboration suites enable real-time co-creation and feedback. Google Workspace for Education serves as an illustration of these suites. The platforms provide educators with tools to effectively customize their learning materials according to Aldoayan et al. (2020). The platforms enable inclusive practices through adaptive resource customization for individual learner needs. Virtual Reality (VR) and Augmented Reality (AR) applications serve as strong tools which enable the simulation of real-world scenarios. The applications improve student engagement and retention specifically for students with learning disabilities. The existing research about their specific effects in this field remains in the early stages of development.

Mobile and Community Outreach

Mobile learning initiatives expand educational resources from traditional classrooms to reach students in community-based locations. The distribution of devices together with community hotspots serves as a vital method to connect underserved areas according to Cadet et al. (2023). Mobile labs together with community technology centers serve as solutions to address both connectivity and digital literacy challenges in rural areas. These solutions work best in situations where institutional backing is restricted (Malone et al., 2020). Mobile educational outreach units deployed in communities provide substantial improvements to learning resource accessibility. Mobile solutions demonstrate their ability to establish fair educational opportunities through these initiatives in difficult circumstances.

Trends in Special Education Technology Integration

Personalization through AI

AI facilitates adaptive learning systems. These systems modify content difficulty based on individual performance. This supports differentiated instruction for students with autism, ADHD, and other special needs (Mehta et al., 2023). AI-driven platforms use predictive analytics. They identify learners at risk of disengagement. This enables educators to implement timely interventions. These interventions can enhance educational engagement. These systems adapt to specific learning profiles of students. This contributes to a more tailored educational experience.

Early Screening and Intervention

AI-driven screening tools detect learning difficulties early. This facilitates prompt support. It has been shown to reduce long-term achievement gaps (Lutfi, 2025). Machine learning algorithms analyze student interaction patterns. They customize interventions accordingly. This improves both efficiency and educational outcomes. Early identification and customized assistance are crucial. They address specific needs of learners with special educational requirements.

Open Educational Resources (OER)

Open Educational Resources (OER) provide low-cost, customizable content. Educators can adapt this content to meet diverse learner needs (Bliss & Tuiloma, 2022). Collaborative OER repositories allow sharing of successful adaptations. This fosters innovation driven by peer collaboration. Educators gain access to customizable educational materials. These can be modified to suit individual pupils. This increases the potential for inclusive pedagogical practices (Ali et al., 2022). OER promotes accessibility by reducing costs. It also encourages collaborative efforts among educators. This improves educational experiences of students with special needs.

Transformations and Case Studies

Case Study: Comprehensive AI-Powered Inclusive Education Initiative

This European initiative deployed an AI-powered tutoring system across classrooms in Germany, the Netherlands, Sweden, Finland, and Denmark. It targets students with dyslexia, ADHD, and autism spectrum disorders. The program included thousands of students with learning disabilities over the three years. The intelligent tutoring system uses natural language processing to deliver personalized instruction in reading, writing, and mathematics. It adapts to each learner's patterns and needs. The system analyzes reading behaviors, error types, and engagement signals. It adjusts content complexity and offers support in real time.

The implementation framework emphasizes teacher development through initial training, peer collaboration, and ongoing mentoring. Monthly learning communities provided support and troubleshooting assistance. The training covered AI ethics and data privacy. The principles of Universal Design for Learning (UDL) guided the system design

(Obeid et al., 2024). It offers adjustable interfaces and multimodal representations for accessibility. Progress-monitoring dashboards provide insights into teachers, students, and families.

Students with dyslexia have shown improved reading comprehension. Those with ADHD demonstrated better attention and task completion than those without ADHD. Writing proficiency increased with real-time feedback. Learners reported higher confidence and inclusion with support that did not highlight their difficulties. Teachers gained better insights into the learning patterns. The challenges included technical integration issues and teacher learning curves with data interpretation. Connectivity requirements and concerns regarding algorithmic bias were also present. These issues were addressed through support systems and ethical oversight.

Case Study: Virtual Reality Accessibility and Inclusion Program

A large urban school district in the United States launched a virtual reality (VR) program. It provides experiential learning for students with physical disabilities. These students are traditionally excluded from field trips. The initiative began during the COVID-19 pandemic. It has expanded to cover dozens of schools and hundreds of students. These students had mobility impairments, chronic health conditions, sensory disabilities, or relied on wheelchairs to move. The program created an immersive experience. These include historical sites, natural environments, museums, scientific facilities, cultural landmarks, and workplace simulations.

Special education teachers, therapists, students with disabilities, and subject matter experts collaborated on this project. They developed virtual field trips that were aligned with curricular goals and state standards. The VR system incorporates multiple interaction modes. These include voice commands, eye tracking, adapted controllers, and switch access. It also provides alternative sensory channels for sensory impairments. Specialized accommodations were also available. These include adjustable headset mounts, alternative input devices, and motion sensitivity support.

The implementation involves several aspects. These include hardware/software adaptations, educator training on accessibility and integration, and technical support. Regular feedback from students, teachers, and families enables continuous improvement. Students have shown gains in various areas. These include content knowledge, spatial reasoning, and problem-solving skills. Engagement exceeded the levels of traditional instruction. Students requested more VR exposure in their training. The program enhances inclusion. Students participated in previously inaccessible experiences. It improved peer relationships through collaborative VR use. Families reported increased enthusiasm for school. This led to the expansion of home lending and family training programs.

Case Study: Rural Mobile Digital Inclusion Initiative

This initiative evaluated mobile digital laboratory services across rural communities in Montana, Wyoming, and North Dakota, focusing on technology access and digital literacy for students with disabilities. The program tracked participants, including students with disabilities, families, educators, and service providers. It addressed rural barriers, including limited broadband, geographic isolation, and scarce expertise. Mobile labs bring technology, training, and support directly to communities via equipped vehicles staffed by specialists.

The services included hands-on training, device lending, technology demonstrations, and consultations for inclusive design. The equipment included communication tablets, adaptive devices, eye-tracking systems, and mobility aids for tailored recommendations. The program helped schools develop integration plans and access funding to build their local capacity. Partnerships with libraries, community centers, and tribal councils ensure cultural responsiveness. Local volunteers were trained to provide basic support. Strategic planning involves cross-sector collaboration for funding and partnerships with vendors for reduced-cost devices.

Impact assessments showed lasting improvements in digital literacy and sustained device use. The participants reported increased confidence, independence, and enhanced participation. Families became better advocates for their children. Community effects included increased disability awareness and inclusion initiatives. The challenges included remote connectivity, weather-related transportation, extensive travel, and scheduling. Sustainability concerns focus on operational costs, suggesting hybrid models of mobile and fixed supports. Outcomes were strongest when community partnerships provided ongoing support.

Challenges and Future Directions

Multiple systemic barriers exist to overcome the digital divide in special education. The lack of sufficient and uneven funding prevents the large-scale implementation of assistive and adaptive technologies. The situation becomes most challenging when resources are limited and the area is rural. Policy support inconsistencies directly stem from funding problems. Innovations fail to scale up because there are no mandates and no standardized funding models. Teacher readiness is another significant barrier. The majority of educators do not possess enough training in special-education pedagogy. Teachers encounter difficulties when implementing digital tools because they struggle to use them effectively. The available technologies end up being either underused or misused because of this situation.

The existing infrastructure problems make access challenges worse. The combination of unstable network connections and insufficient devices creates major challenges for rural areas. The ethical and privacy issues related to AI-driven systems create additional challenges for implementation. Student data governance weaknesses can lead to stakeholder trust breakdowns. The implementation of algorithmic bias in educational systems creates trust problems because it produces unfair learning paths for students. The maintenance of long-term impact becomes challenging because local capacity needs to be permanently embedded. The success of technological interventions depends on external technical support continuing after its termination. The same is true when initial grants are exhausted.

The likelihood of this happening increases when top-down implementation methods replace co-designed approaches with local communities.

To move from isolated successes to systemic transformation, the field requires strategically targeted research, policy, and practice interventions. Longitudinal studies are essential for understanding the lasting impacts across diverse disability categories and socio-geographic contexts. These studies should capture both the learning outcomes and socioemotional dimensions. Policy advocacy should push for equitable funding formulas, professional development requirements, and the inclusion of assistive technologies in core special education provisions. Co-design approaches can produce culturally responsive and contextually appropriate solutions and boost ownership. These approaches should involve students with disabilities, their families, educators, and local communities from the outset.

The development of teacher capabilities serves as a solution to connect the existing gaps between usage and quality standards. The development of sustained professional learning communities together with mentorship programs and embedded instructional coaching will help achieve this goal. The development of ethical AI frameworks will protect learner autonomy while maintaining trust in AI systems. The frameworks need to maintain transparency while being auditable and they should also work to minimize bias. The successful models need hybrid delivery systems to achieve large-scale implementation. The delivery system should unite mobile outreach with fixed local hubs to use open educational resources and shared repositories which decrease costs and speed up adaptation. A resilient ecosystem will emerge through the development of strong multi-stakeholder partnerships. The partnerships need to consist of government agencies together with NGOs and technology providers and community organizations. These partnerships will preserve infrastructure while supporting ongoing improvement and establishing inclusive practices that extend past short-term projects.

Conclusion

The conclusion stresses that special education digital divide bridging needs sustained holistic efforts which understand specific contexts. The achievement of this goal requires more than single technological solutions. Success depends on integrating multiple components: appropriate assistive tools that meet varied learner needs; Adaptive, AI-enhanced platforms that personalize learning without replacing human judgment; proactive community and mobile outreach to extend access beyond traditional settings; and robust policy and funding frameworks that institutionalize equity. The digital divide requires specific attention to the context in which it exists. The digital access and usage quality and challenges differ between urban and rural areas and low-resource and culturally diverse environments. Solutions need to be customized and developed through stakeholder collaboration while considering local environmental factors. Teacher capacity building is thus crucial. The failure of well-resourced technologies to create inclusive impact occurs when professional development and mentorship and embedded support structures are not sustained.

Collaborative networks for resource sharing are crucial. These networks combine the expertise of educators, families, technologists, and policymakers to create feedback loops and collective ownership. Ethical considerations, particularly regarding AI and data privacy, must be addressed. Transparent frameworks are necessary to maintain trust and ensure equitable outcomes in AI healthcare applications. Lasting transformation requires a transition from pilot projects to scalable, hybrid delivery ecosystems. These ecosystems should blend centralized and decentralized support. They should leverage open resources and multi-stakeholder partnerships to sustain infrastructure, continuous refinement, and inclusion. By embracing these interdependent elements—technology, people, policy, and place— special-education systems can move toward genuine digital inclusion. This approach enables learners of all abilities and backgrounds to participate fully and confidently in learning.

References

1. Adeleye, O. O., Eden, C. A., & Adeniyi, I. S. (2024). Educational technology and the digital divide: A conceptual framework for technical literacy inclusion. International Journal of Science and Research Archive, 12(1), 150–156. https://doi.org/10.30574/ijsra.2024.12.1.0405
2. Aldoayan, M., Sahandi, R., John, D., & Çetinkaya, D. (2020). A conceptual framework for cloud-based collaborative online course provision. In Proceedings of the 2020 9th International Conference on Educational and Information Technology (pp. 27–31). https://doi.org/10.1145/3383923.3383952
3. Ali, L., Knight, C., & Schroeder, U. (2022). Open educational resources in higher education. International Journal of Innovative Teaching and Learning in Higher Education, 3(1), 1–14. https://doi.org/10.4018/ijitlhe.313374
4. Alkhoui, D. (2021). Recommendations to improve education for students with autism through distance learning strategies and assistive technologies during the COVID-19 pandemic. International Journal of Humanities and Applied Social Science, 1–8. https://doi.org/10.33642/ijhass.v6n3p1
5. Azubuike, O. B., Adegboye, O., & Quadri, H. A. (2021). Who gets to learn in a pandemic? Exploring the digital divide in remote learning during the COVID-19 pandemic in Nigeria. International Journal of Educational Research Open, 2, 100022. https://doi.org/10.1016/j.ijedro.2020.100022
6. Barlow, A. T. (2021). Special issue: Closing the digital divide. Mathematics Teacher: Learning and Teaching PK-12, 114(10), 734–735. https://doi.org/10.5951/mtlt.2021.0227
7. Betlej, A., & Danilevičа, A. (2022). Learning technologies for people with mild intellectual disabilities: From digital exclusion to inclusive e-education in network society. International Journal of Research in E-Learning, 8(2), 1–20. https://doi.org/10.31261/ijrel.2022.8.2.07.
8. Bliss, T., & Tuiloma, S. (2022). Open educational resources. EdTechnica. https://doi.org/10.59668/371.8286.

9. Bong, W., & Chen, W. (2021). Increasing faculty's competence in digital accessibility for inclusive education: A systematic literature review. International Journal of Inclusive Education, 28(2), 197–213. https://doi.org/10.1080/13603116.2021.1937344
10. Cadet, K., Baker, D., & Brown, A. (2023). A qualitative assessment of provider satisfaction and experiences with a COVID-19 community mobile health clinic outreach model in underserved Baltimore neighborhoods. SAGE Open Medicine, 11. https://doi.org/10.1177/20503121231152090
11. Hornby, G. (2015). Inclusive special education: Development of a new theory for the education of children with special educational needs and disabilities. British Journal of Special Education, 42(3), 234–256. https://doi.org/10.1111/1467-8578.12101
12. Li, Y. (2024). The impact of the old-age digital divide on household financial vulnerability. Academic Journal of Business & Management, 6(5). https://doi.org/10.25236/ajbm.2024.060518.
13. Lutfi, R. (2025). Neutrosophic clustering in adaptive AI learning for students with Down syndrome. Journal of Digital Learning and Education, 5(1), 53–66. https://doi.org/10.52562/jdle.v5i1.1539
14. Malone, N. C., Williams, M. M., Fawzi, M. C. S., Bennet, J., Hill, C., Katz, J. N., … & Oriol, N. E. (2020). Mobile health clinics in the United States. International Journal for Equity in Health, 19(1). https://doi.org/10.1186/s12939-020-1135-7
15. Mathrani, A., Sarvesh, T., & Umer, R. (2021). Digital divide framework: Online learning in developing countries during the COVID-19 lockdown. Globalisation, Societies and Education, 20(5), 625–640. https://doi.org/10.1080/14767724.2021.1981253.
16. McGinty, J. (2020). Accessible digital learning materials for inclusive adult education. Adult Learning, 32(2), 96–98. https://doi.org/10.1177/1045159520961470.
17. Mehta, P., Chillarge, G. R., Sapkal, S. D., Shinde, G. R., & Kshirsagar, P. S. (2023). Inclusion of children with special needs in the educational system, artificial intelligence (AI). In Advances in Educational Technologies and Instructional Design (pp. 156–185). https://doi.org/10.4018/979-8-3693-0378-8.ch007.
18. Muazu, F. A., Adedoyin, F. F., Doğan, H., Mavengere, N., & Whittington, P. (2024). The use of mobile learning in special education needs and disabilities (SEND) settings: State-of-the-art classification of studies. In Proceedings of the 17th International Conference on PErvasive Technologies Related to Assistive Environments (pp. 486–495). https://doi.org/10.1145/3652037.3663915.
19. Obeid, M. S. N., & Passey, D. (2024). Enhancing digital access in higher education: Accessibility tools and training for all students and faculty in the Saudi Arabian context. Lancaster University. https://eprints.lancs.ac.uk/id/eprint/226171/
20. Rani, P., Acharya, B.B., & Trehan, K. (Eds.). (2025). Digital Inequalities in Media Education in South Asia: Context and Consequences of the Covid-19 Pandemic (1st ed.). Routledge. https://doi.org/10.4324/9781003432074.

21. Seale, J. (2022). It's not all doom and gloom: What the pandemic has taught us about digitally inclusive practices that support people with learning disabilities to access and use technologies. British Journal of Learning Disabilities, 51(2), 218–228. https://doi.org/10.1111/bld.12497.
22. Simkova, I., Вайнагій, T., Mikhnieva, Y., & Serheieva, O. (2024). Digital inclusion in English language teaching in Ukraine. International Journal of Emerging Technologies in Learning (iJET), 19(02), 4–13. https://doi.org/10.3991/ijet.v19i02.43991.
23. Werfhorst, H., Kessenich, E., & Geven, S. (2022). The digital divide in online education: Inequality in digital readiness of students and schools. Computers and Education Open, 3, 100100. https://doi.org/10.1016/j.caeo.2022.100100
24. Wen, X., & Tian, B. (2024). How does digital integration influence the mental health of low-income populations? Healthcare, 12(24), 2593. https://doi.org/10.3390/healthcare12242593.

GOVERNMENT INITIATIVES IN DIGITAL EDUCATION: PM EVIDYA, DIKSHA AND SWAYAM

Dr. Yashvinder Kapil
I/c CBR, GRIID, Chandigarh

Dr. J. Sujathamalini
Professor & Head,
Department of Special Education & Rehabilitation Science, Alagappa University

Introduction

The advent of the Information and Communication Technology (ICT) has brought about significant changes in the world education and has produced a new system of learning design, delivery and experience. Education is not in a physical classroom today but rather has been transfigured into digital ecosystems where it can be learned at any time or place. Governments across the globe are using technology to meet the demands of access, equity, quality and inclusion, therefore sealing the traditional education disparities.

The landmark policy frameworks that have been critical in supporting this change in India include the Digital India Mission and the National Education Policy (NEP) 2020 that highlight the importance of incorporating ICT in the teaching-learning process (MoE, 2020). The NEP also clearly identifies the significance of digital tools in personalised and inclusive learning and requests the utilisation of technology to curb the inequalities in different regions, socio-economic status, and abilities.

The rapid spread of the COVID-19 pandemic in 2020 only emphasized the necessity of powerful digital learning solutions. The long-term shutdowns of schools, limitation of physical movement, and abrupt transitions to distance learning revealed the underlying inequality in access to education. In its turn, the Government of India quickly amplified its digital infrastructure and introduced programs that turned out to be the foundation of continuity in education in the times of crisis. Some of the biggest of such initiatives include PM eVIDYA, DIKSHA and SWAYAM.

It is not a temporary solution but a long-term investment into creating a strong, inclusive, and future-ready education system. This chapter explains these three initiatives individually, with the background, goals, characteristics, successes, and difficulties, but notes that they will influence the future development of the Indian digital learning environment.

Keywords: *Digital Education; PM eVIDYA; DIKSHA; SWAYAM; National Education Policy (NEP) 2020; Inclusive Learning*

PM eVIDYA: Unifying Digital Education

Origins and Objectives

Introduced in May 2020 as part of Atma Nirbhar Bharat Abhiyan PM eVIDYA was planned as a single umbrella programme designed to consolidate all digital and online learning activities in India. Although the immediate requirement was to alleviate the learning disruptions that were brought about by the COVID-19, the larger mission of PM eVIDYA was to institutionalise the concept of digital learning in India as a part of delivering education (MoE, 2020).

The initiative is also aligned with the ambitions of NEP 2020 that promotes the idea of blended learning and technological integration in order to foster equity, inclusivity, and lifelong learning.

Key Components

PM eVIDYA will be a multi-digital and broadcast strategy that will be as inclusive as possible:

- DIKSHA Portal: A central repository of e-contents in 30+ languages to teachers and learners.
- One Class, One Channel: A package of 12 specific DTH channels name in SWAYAM Prabha, each channel will have NCERT-based content depending on the classes 1-12.
- Radio and Community Radio: The Radio and Community Radio help to reach learners not connected to the internet in rural and remote settings.
- Accessible Learning: Materials added in India Sign Language and support with the disabled children according to the RPwD Act 2016 (NCERT, 2021).
- Digital Infrastructure: Cooperation with state governments to make it more universal and consistent.

Impact

The PM eVIDYA has made digital content more democratic with a combination of TV, radio and online resources. The radio and DTH channels were of great use to those students who lacked access to the internet. Millions of students have been reported to have been able to access learning materials during the lockdown, which has secured continuity in education (Mishra, Gupta, and Shree, 2020).

This initiative also prefigured the blended learning, in which digital resources are used to supplement classroom education, thus increasing flexibility and customisation to education.

DIKSHA: Empowering Teachers and Learners

Concept and Vision

DIKSHA (Digital Infrastructure of Knowledge Sharing) was introduced in 2017, and it is the flagship Indian digital school education platform. In contrast to PM eVIDYA, which is more extensive, DIKSHA is curriculum and teacher-focused, and aimed at benefiting teachers, students, and parents alike through a single nation, one digital platform (NITI Aayog, 2020).

The vision of DIKSHA is twofold:

1. To ensure digital resources that are aligned to the curriculum are available to all learners.
2. To give teachers digital training, tools and capacity building opportunities.

Features

- Curriculum-Linked Resources: NCERT-, SCERTs-, and CBSE-curriculum materials.
- QR-Coded Textbooks: Textbooks with QR-codes give immediate access to online content (NCERT, 2021).
- Teacher Development: Professional training modules, assessments and capacity building courses.
- Multilingual Content: Material in more than 30 Indian languages to be inclusive.
- Open- Source Flexibility: It is based on the Sunbird framework and it allows states and NGOs to adapt to it (World Bank, 2020).

Achievements

In the pandemic, DIKSHA proved to be a lifeline of school education, where it became widely used in 35 states and UTs. The platform was used by millions of students and teachers and was one of the most successful government-supported digital learning tools in the world (UNESCO, 2021).

The QR-coded textbooks introduced by DIKSHA transformed the textbook usage by connecting the print to the digital text, which meant that students could access the enriched learning content even in the low-tech environments.

SWAYAM: Democratising Higher Education

Genesis and Objectives

SWAYAM (Study Webs of Active Learning by Young Aspiring Minds), which was launched in 2017, was the Indian answer to the global movement of MOOCs (Massive Open Online Course). Its main focus is to make quality education accessible to everyone including school, undergraduate, postgraduate and vocational education.

The program reflects the three key principles of education policy equity, access, and quality and offers opportunities to both formal students and lifelong learners (UGC, 2018).

Features

- Different Course Selections: Includes engineering, management, law, humanities and vocational studies.
- Credit Transfer: Universities have permission to receive no less than 40 percent of credits by means of SWAYAM courses (UGC, 2018).
- Faculty Involvement: Courses taught by professors and participants of IITs, IIM, NPTEL, and IGNOU, and other leading institutions.
- Low-priced Certification: No tuition fees, with small charges on certification.
- Interactive Learning: It has video lectures, assignments, discussion forums, and self-assessment.

Achievements

SWAYAM has become an important hub to higher education in India with over 2,000 courses and millions of enrolments. Not only does it increase access but also enhances employability through relevant and skill-based courses related to the industry. The fact of its recognition all over the world highlights the role of India in promoting digital education (OECD, 2020).

Comparative Insights

The three initiatives though interrelated cover various sections of the education system:

- PM eVIDYA: This is aimed at school education, inclusivity, and crisis gap bridging.
- DIKSHA: Focuses on alignment of curriculum and empowerment of teachers.
- SWAYAM: Focuses on lifelong learning and higher education, which increases flexibility and employability.

They create an integrated digital learning ecosystem jointly; which is the holistic approach of the government in NEP 2020 (MoE, 2020).

Challenges and Future Directions

Eventually, despite the outstanding success, the difficulties remain:

- Digital Divide: Inequality in access to internet and devices, especially in the rural parts of India (World Bank, 2020).
- Capacity Building: teachers and parents are usually not digital literate enough.
- Localization Requirements: There is a requirement of increased culturally appropriate, regional language content.
- Assessment and Evaluation: The online examination and assessment systems are not developed.

Future Priorities

- The invention of Artificial Intelligence (AI) in personalised learning.
- Enhancing its universal accessibility and especially among students with disabilities.
- Development of international partnerships to increase the presence of digital education in India (UNESCO, 2021).

Conclusion

Programs like PM eVIDYA, DIKSHA, and SWAYAM by the government are a paradigm shift in the way education in India is done. They are the examples of how technology can democratise learning, deal with the issues of equity and access, and the future-ready education systems.

PM eVIDYA has proved to be effective in terms of a cohesive platform including television, radio, and digital media in order to cover different learners, especially those who are in underserved regions. DIKSHA has transformed the teaching- Learning process in the sense that it has connected the curriculum, pedagogy, and professional development on one platform that has provided an opportunity to building capacity in teachers on a large scale.

In providing massive online courses and credit transfer services, SWAYAM has made India a contributor to the MOOC movement worldwide, both in strengthening higher education and lifelong learning. Together, these efforts underscore the government drive to achieve the objectives of the National Education Policy (NEP) 2020 that views equity, inclusion, and quality as the pillars of education. They are also indicative of how India in response to the challenges revealed by the COVID-19 pandemic has been proactive in its reaction to these crises and turned short-term responses to the crisis into long-term structural adjustments.

Nevertheless, to maintain these gains, a multi-dimensional approach is needed: addressing the digital divide by making devices and internet access affordable, improving digital literacy of both teachers and learners, and localizing the content to make it culturally relevant. Increasing access to students with disabilities and adding innovations that may include artificial intelligence, virtual reality, and adaptive learning systems will add to the richness of the digital ecosystem even further.

To summarize, projects PM eVIDYA, DIKSHA, and SWAYAM are not only technological endeavors but a representation of the resiliency, inclusiveness, and innovativeness of the educational sector. They provide a guideline to other developing countries that are struggling to reconcile the traditional and technological aspects in education. India can improve its own education ecosystem as it increases efforts to scale these initiatives, but it can also be at the forefront of defining how digital and inclusive education should be in the future of the world.

References

1. IGNOU. (2019). *Annual report 2018–2019*. Indira Gandhi National Open University.
2. Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open, 1*(100012), 1–8. https://doi.org/10.1016/j.ijedro.2020.100012
3. Ministry of Education (MoE). (2020). *National Education Policy 2020*. Government of India.
4. Ministry of Education (MoE). (2021). *Digital education initiatives*. Government of India. https://www.education.gov.in
5. NCERT. (2021). *Digital content and QR-coded textbooks*. National Council of Educational Research and Training.
6. NITI Aayog. (2020). *Strategy for New India @ 75*. Government of India.
7. OECD. (2020). *Education responses to COVID-19: Embracing digital learning and online education*. Organisation for Economic Co-operation and Development.
8. UGC. (2018). *SWAYAM regulations for credit transfer*. University Grants Commission, Government of India.
9. UNESCO. (2021). *State of the education report for India 2021: No teacher, no class*. UNESCO New Delhi.
10. World Bank. (2020). *India learning in the time of COVID-19: Digital education initiatives*. The World Bank.

PARENTAL IMPOVERISHMENT AND HOME-BASED INTERVENTIONS

Dr. Yashvinder Kapil
I/c CBR, GRIID, Chandigarh
Dr. Bibhakar Vishwakarma
Technical Supervisor & Faculty in Special Education, GRIID Chandigarh

Introduction

Parental impoverishment is a multidimensional and complex phenomenon which is not only about the absence of financial means. It comprises emotional exhaustion, mental pressure, lack of social support, and access to less information and opportunities. The burden of societal stigma is increased in parents that have children with developmental disabilities due to the continued need to provide care, regular medical expenses, limited educational opportunities, and the weight of societal stigma. This has led to financial stress in families as well as feelings of powerlessness, and social withdrawal.

The absence of traditional care-giving systems in the Indian context, whereby the family structure is changing to a nuclear society, further strains the parental roles. Also, the lack of infrastructural support that is disability-friendly, the lack of knowledge about available welfare programs, and the uneven implementation of such policies as the Rights of Persons with Disabilities Act (2016) and the National Education Policy (2020) aggravate the vulnerability of parents.

The impoverishment of parents is a conflict that needs sensitive interventions that are sensitive to both emotional and contextual family realities. Those strategies that are developed at the comfort of the family, home-based interventions, are especially efficient because they not only decrease the logistical and financial costs involved in accessing services but also enable the parents to be active participants in the process of child growth and development. The interventions are based on daily routines, promote routines, and positive parent-child interactions, which enhances resilience in the family.

This chapter thus considers parental impoverishment as a multi faceted problem, its effects on child development and family welfare and how structured home-based interventions can be applicable to alleviate its effects. It also provides the information about research findings, case studies, and policy models, showing how these interventions may be utilized as viable, sustainable, and family-focused solutions.

Keywords: *Parental impoverishment; Home-based interventions; Family empowerment; Developmental disabilities; Inclusive support*

Understanding Parental Impoverishment

Conceptual Framework

Poverty in parents is not financial in nature. It also encompasses:

- Economic impoverishment: Low income, unstable jobs and excessive spending on health.

- Psychosocial impoverishment: Stress, stigmatization, isolation, lack of agency.
- Informational impoverishment: Inability to access knowledge of child development, disability management or services available.
- Relational impoverishment: Poor family and community support.

The Ecological Systems Theory by Bronfenbrenner gives a valuable framework of the effect of various factors in the environment that cause impoverishment at the family level. Being poor in one area (e.g. economic) often leads to poor results in other (e.g. psychosocial) and this is a cycle that is very hard to break.

Impact on Families

- On Parents: High stress, depression risk, caregiver burnout, and marital stress.
- On Children: Developmental delay, inadequate school readiness, and inadequate access to health and education services.
- On Society: Higher reliance on welfare programs and lower participation on the work force.

The Need for Home-Based Interventions

Rationale

Home based interventions offer a way out as opposed to the institutionalized or clinic based approaches. They deal with two significant issues accessibility and contextual relevance. Practitioners can be able to fit strategies to cultural, social, and economic settings by targeting the families in their natural environment.

Benefits

1. Accessibility: The families that are less mobile, financially constrained, or geographically challenged enjoy the services at home.
2. Parent Empowerment: Parents get to be trained as partners and active agents in the development of their child.
3. Contextual Learning: Strategies are incorporated into daily activities and the natural environment and they therefore are sustainable.
4. Less Stress: Interventions cut down on travelling, economic pressure and anxiety of separation.

Types of Home-Based Interventions

1. Parent Training and Capacity Building

Skill Development: Educating parents about behavior management, communication stimulation, and simple techniques of therapy.

- **Problem-Solving: assisting parents to come up with crisis coping mechanisms.**
- **Self-Care: Educating about stress management and mindfulness.**

2. Early Intervention Programs

- Developmental delays/disabilities in children.
- Activities: Cognitive stimulation, motor activities, language development, which are carried out by parents under the guidance of a professional.

3. Health and Nutrition Support

- Community health worker home visits to measure child development, offer immunization services, and offer nutritional supplements.

4. Psychosocial Support

- Peer-support groups and counseling held in the communities.
- Enhancement of social networks to curb isolation and stigmatization.

5. Inclusive Education Support

- Education of parents about the assistive technology and learning resources at home.
- Advice on inclusion, homework assistance and closing school-home disparities.

Evidence from Research

A number of studies point out the usefulness of home-based interventions:

- Another study conducted by UNICEF (2019) found out that home interventions guided by parents in low-income households showed great effects on child cognitive and language outcomes.
- The researchers examined the study by Kaul and Sankar (2020) and determined that a home-based early childhood education program in India increased school preparedness and minimized learning gaps.
- WHO (2021) highlighted that rehabilitation based on communities when extended to homes enhances parental confidence and decreases stress.

These results indicate that home-based interventions can not only do good to children but also provide resilience to the family and avoid future impoverishment.

Challenges in Implementation

1. Resource Constraints: Low number of trained professionals, and funding.
2. Culturewise Problems: Stigma, gender roles and reluctance to external interference.
3. Sustainability Problems: Crisis in long-term participation without system support.
4. Policy Lapses: Lack of national disability and child welfare policies on integrating home-based strategies.

Policy and Practice Recommendations

1. Coordination with Government Programs: Coordinating home-based interventions with the national policy shows like Integrated Child Development Services (ICDS), Skill India, and National Education Policy 2020.
2. Capacity Building of Frontline Workers: Training of Anganwadi workers, ASHAs, and other volunteers in the community to implement interventions targeting families.
3. Technology-Supported Intervention: Using mobile applications, tele-counseling, and digital technologies to support and observe parents.
4. Family-Centered Approach: The policy is to include parents as important partners in the intervention planning and implementation processes.
5. Monitoring and Evaluation: Establishing the outcome measures like parental well-being, child progress, and resiliency of the family.

Case Illustration

The family was a home-based early intervention program involving community workers and the family of colonies Chandigarh with an intellectual disability child. Weekly visits had the mother taught how to perform daily routines with communication and motor exercises. In more than 12 months, there was a significant enhancement of the functional skills of the child, and the mother indicated that she experienced less stress and felt more confident about managing her child. The case shows that structured home-based interventions are transformative in alleviating impoverishment among parents.

Conclusion

Impoverishment amongst parents is a vehemently intertwined issue that has a financial, psychological, and social aspect and its effects are felt in the generations to come. The challenges experienced by families as they raise children with disabilities are usually disproportionate, with economic deprivation coming in conflict with emotional strain, social stigma and institutional neglect. Lack of proper support can mean that the parents will not be able to offer regular care, and child development would be affected, and they will become dependent on the welfare systems in the long term.

The home-based interventions can be viewed as a revolutionary solution to these problems. Such interventions directly mitigate access, affordability and sustainability barriers by integrating therapeutic practices, educational-focused strategies, and psychosocial support in the home environment. More importantly, they enable parents, making them cease to be the passive receivers of services, but active participants of the development of their child. This gives them empowerment which restores parental confidence, lowers stress and enhances family functioning.

To have a sustainable effect on home-based interventions, they have to be accepted as a component of disability services and mainstream child development programs. It involves cross-sectoral working of the health, education, and social welfare systems, and the capacity-building of community workers, the adoption of digital tools, and the integration with the national platforms, such as ICDS, Skill India, and NEP 2020.

Finally, the issue of parental impoverishment should not only be addressed concerning the reduction of the family suffering but also the right of all children to grow up in a healthy family and community. It is through the empowerment of families through home-based interventions that societies can advance to greater equity levels, as well as the inclusion level and sustainable development; providing a situation in which children and their parents can both thrive with dignity and strength.

References

1. Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.
2. Emerson, E. (2003). Mothers of children and adolescents with intellectual disability: Social and economic situation, mental health status, and the self-assessed social and

psychological impact of the child's difficulties. *Journal of Intellectual Disability Research*, 47(4–5), 385–399. https://doi.org/10.1046/j.1365-2788.2003.00498.x

3. Hastings, R. P., & Brown, T. (2002). Coping strategies and the impact of challenging behaviors on special educators' burnout. *Mental Retardation*, 40(2), 148–156. https://doi.org/10.1352/0047-6765(2002)040<0148:CSATIO>2.0.CO;2
4. Kaul, V., & Sankar, D. (2020). Early childhood education and school readiness in India. *International Journal of Early Childhood*, 52(3), 249–267. https://doi.org/10.1007/s13158-020-00274-6
5. Kyzar, K., Turnbull, A. P., Summers, J. A., & Gomez, V. A. (2012). The relationship of family support to family outcomes: A synthesis of key findings from research on severe disability. *Research and Practice for Persons with Severe Disabilities*, 37(1), 31–44. https://doi.org/10.2511/027494812800903247
6. McConkey, R., & Collins, S. (2010). The role of support staff in promoting the social inclusion of persons with an intellectual disability. *Journal of Intellectual Disability Research*, 54(8), 691–700. https://doi.org/10.1111/j.1365-2788.2010.01295.x
7. Resch, J. A., Mireles, G., Benz, M. R., Grenwelge, C., Peterson, R., & Zhang, D. (2010). Giving parents a voice: A qualitative study of the challenges experienced by parents of children with disabilities. *Rehabilitation Psychology*, 55(2), 139–150. https://doi.org/10.1037/a0019473
8. Turnbull, A., Turnbull, R., Erwin, E., & Soodak, L. (2015). *Families, professionals, and exceptionality: Positive outcomes through partnerships and trust* (7th ed.). Pearson.
9. UNICEF. (2019). *Parenting interventions: Evidence from low- and middle-income countries*. UNICEF Office of Research.
10. World Health Organization. (2021). *Community-based rehabilitation: CBR guidelines*. WHO.
11. Ylvén, R., Björck-Åkesson, E., & Granlund, M. (2006). Attitudes, experiences, and strategies of parents of children with disabilities: Implications for early childhood intervention. *Early Child Development and Care*, 176(6), 653–671.
12. https://doi.org/10.1080/03004430500147471
13. Zuna, N. I., Turnbull, A. P., & Summers, J. A. (2009). Family quality of life: Moving from measurement to application. *Journal of Policy and Practice in Intellectual Disabilities*, 6(1), 25–31. https://doi.org/10.1111/j.1741-1130.2008.00196.x

EVIDENCE BASED PRACTICES AND OUTCOME EVALUATION ON ENHANCING EYE HAND COORDINATION THROUGH GAME OF DART FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

B. Nithya Prabha
M.SC.,M.Ed. (Spl.edn(ASD)), Lecturer(c), NIEPMD, Chennai

Introduction

Autism is a complex developmental disability that typically appears during the first three years of life. The result of a neurological disorder that affects functioning of the brain, autism impacts the normal development of the brain in the areas of social interaction and communication skills. Children and adults with autism typically have difficulties in verbal and non-verbal communication, social interactions, and leisure or play activities (Autism Society of America, 2003). Autism spectrum disorder (ASD) is a developmental disability that can cause significant social, communication, and behavioral challenges. The term "Spectrum" refers to the wide range of symptoms, skills, and levels of impairment that people with ASD can have. ASD affects people in different ways and can range from mild to severe. People with ASD like behaviour issue, Eye-hand coordination, sensory issues, such as difficulties with social interaction, but there are differences in when the symptoms start, how severe they are, the number of symptoms, and whether other problems are present. The symptoms and their severity can change over time. The behavioral signs of ASD often appear early in development. Many children show symptoms by 12 months to 18 months of age or earlier (NIDCD, 1988).

Autism spectrum disorders are complex Neuro- developmental disorders characterized by qualitative impairments in three domains: social interaction, communication, and repetitive, stereotyped behaviour. ASD can have a detrimental impact on the well-being of affected individuals. These symptoms often begin by the age of three years, and persist throughout the life span. ASD are associated with mental retardation and seizure disorders in a significant number of cases, and are influenced heavily by genetic factors.

Triad of Impairment

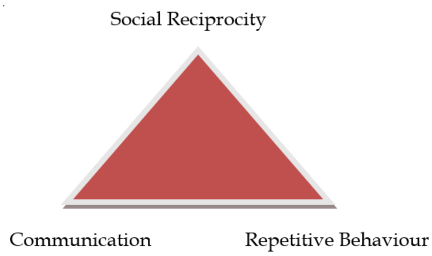


Fig 1.1 Triad of impairment

Autism shows the core feature of triad of impairment in varying degrees. These include:

- Persistent difficulties with social communication
- Persistent difficulties with social interaction
- Rigid and repetitive behavior, resistance to change or narrowed interests.

These core autism symptoms are persistent throughout an individual's life but will differ in severity according to various factors, including age, the presence of a learning disability or other co-morbid conditions, and any therapy or treatment.

Eye-hand coordination among Children with Autism Spectrum Disorder:

The control of everyday movements such as reaching, grasping, walking, gaze direction, etc., involves the concerted activity of neurocognitive processes, sensory processes, and reflexes. Ongoing movements are planned, initiated, guided, monitored, and adjusted to accommodate environmental contingencies. There is emerging insight that autism spectrum disorder (ASD) not only affects communication, cognition, mood and emotion, and behavioral regulation (American Psychiatric Association [APA], 2013), but also affects the control of movement. Even though sub-optimal motor skills are not considered a core feature of ASD, clinicians and researchers are well aware of motor deficits in ASD.

Signs of poor Eye-hand coordination:

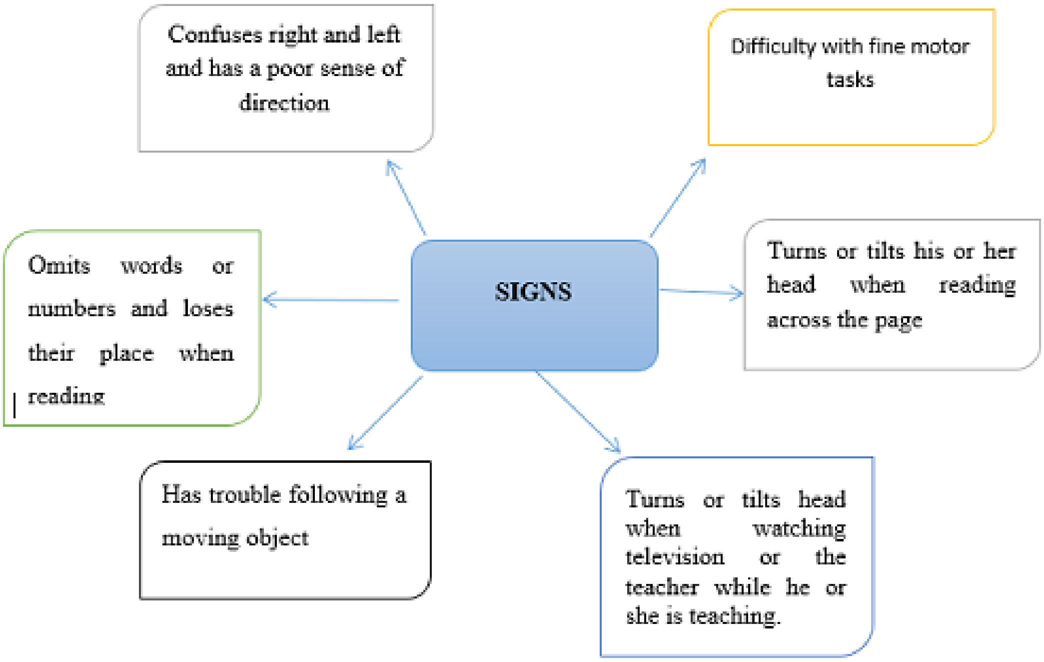


Fig: 1.7 (a) Signs of poor Eye-hand coordination

Eye-hand coordination is the underlying ability that enables individuals to carry out activities that require the simultaneous use of one's hands and their vision. This is essential for a variety of different actions, large and small, that we carried out every single day – catching a ball, writing, cooking, driving and much more. When there is an external stimulus, our eyes are directed towards it. They perceive and gather information which the brain uses to understand where the body is located relative to its surroundings. Simultaneously, the brain also instructs the hands to carry out a specific or determined task based on the visual information that the eyes are receiving.

However, there are a number of people among us who do not exhibit the same degree of effectiveness for such coordination. Children with Autism Spectrum Disorder (ASD) are one such group. When compared with age-matched peers, they show a marked difference in their ability to carry out a number of tasks such as writing, reading, pointing towards a fixed object and in various games and sports too.

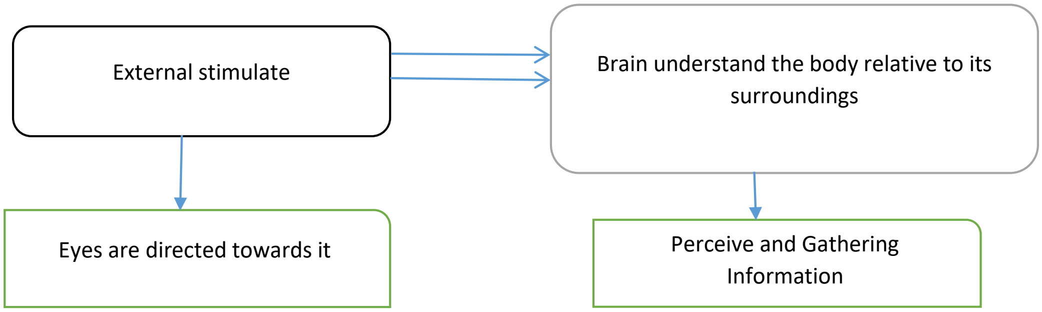


Fig 1.7 (b) Process of eye- hand coordination

Studies have shown that children with ASD might exhibit normal eye-gap effects, but they show no concurrent hand-gap effects when pointing at targets. The key takeaway here is that one can then use activities that can capitalize on this distinction as a tool to develop and improve hand-eye coordination. One such activity is hand weaving. Children who have been taught to use a hand weaving machine show remarkable progress in their hand-eye coordination. The act of weaving involves a tremendous amount of concentration and one can often see children weaving in total silence.

Significance of Eye-hand coordination for children with ASD:

Schlein (1981) Eye-hand coordination in children with autism spectrum disorders (ASD) in comparison with age-matched normally developing peers. The Eye-hand correlation was measured by putting fixation latencies in relation with pointing and key pressing responses in visual detection tasks where a gap-overlap paradigm was used and compared to fixation latencies in absence of manual response. ASD children's showed less efficient Eye-hand coordination, which was particularly evident when pointing towards a target was being fixated. The data of normally developing participants confirmed that manual gap effects are more likely for more complex hand movements. An important discrepancy it was discovered in participants with ASD: beside normal eye gap effects, they showed no concurrent hand gap effects when pointing to targets. This result has been interpreted as a further sign of inefficient Eye-hand coordination in ASD population. Therefore, to improve the Eye-hand co-ordination in Autism children I choose the dart game for my study.

Significance of the Study

Children with autism spectrum disorder have problem in social skill, communication skill, eye contact, etc. This study based on the strategies which will help the children with autism spectrum disorder to develop the Eye-hand coordination through the game of darts. This study is based on the recreational activities since children with autism have difficulty to focus and make sustained attention. Through this activity training the autistic child can focus easily and create interest in the play activity. So that the difficulties in repetitive behaviors, hyperactivity, attention, socialization, communication and eye contact can get overcome.

In this study Game of darts is used to improve Eye-hand coordination, social skill and communication skill for children with autism spectrum disorder. The study will be a guide for teachers to use as an outdoor play activity to improve their focus and Eye-hand coordination.

Objectives:

To find the effect of game of dart in improving Eye-hand coordination for children with autism spectrum disorder.

To compare the impact of game dart in improving Eye-hand coordination among children with autism spectrum disorder.

Hypothesis:

1. There is no significant difference in improving Eye-hand coordination among children with autism spectrum disorder through the game of darts.
2. There is no significant difference in improving Eye-hand coordination among children with autism spectrum disorder through game of darts with respect to socio-demographic data (age and locality)
3. There is no significant difference in improving Eye-hand coordination among children with autism spectrum disorder through the game of darts with respect to distance (1m, 2m, 3m)

Literature review:

Szabo, S., D.A., Neague, N., Teodorescu, S., & Sopa, I. S. **(2020)** evaluated a study on Eye-hand Relationship of Proprioceptive Motor Control and Coordination in Children 10-11 Years. Sample consisted of 110 children, the aged 10–11 years, 60 girls and 50 boys, 50 of them practicing sports, and 60 playing no sports. from five different schools in Targu Mures – Romania. Result found that between genders there is a statistically significant difference with better results in the Eye-hand coordination test and those who practiced sport and those who did not, and also between genders. No statistical difference was found between predominantly leg and arm sports.

Bairi, F., Farsi A., Abdolo, B., & Kavyani M. (2020) examined study on The Effect of Visual and Tennis Training on Perceptual-Motor Skill and Learning of Forehand Drive in Table Tennis Players. The sample size consisted of Forty volunteer female students at the age group of 21 years old were selected and randomly assigned to one of four groups (each group had 10 participants): visual and tennis training group, visual training group, tennis training group, and control group. The results showed that visual and table tennis training had a significant effect on the reaction time (P=0. 001), coincidence-anticipation timing (P=0. 001) and Eye-hand coordination (error time) (P=0. 01). Moreover, visual and tennis training and table tennis training had a significant effect on the acquisition (P=0. 001) and retention of forehand drive.

Kovari, A., Katona, J., & Pop, C. A. (2020) explored a study on Quantitative Analysis of Relationship between Visual Attention and Eye-hand Coordination. A sample size was 11 men and 8 women participated at the age groups of 10-70 years old. This study analyse certain features describing computer mouse cursor motion, examined during the execution of the Trail Making Task, what correlation is there between visual attention and Eye-hand coordination. Result revealed that on the basis of statistical correlation analysis, it was determined, that the fixation parameters of Eye-hand motion are in negative correlation with visual attention, while the distance between the look and the mouse cursor's motion are not correlated to each other.

Smirnov, A. S., Alikovskaia, T. A., Ermakov, P. N., Khoroshikh, P. P., Fadeev, K. A., Sergievich, A. A. Golokhvast, K. S. (2019) conducted a study on Dart Throwing with Open and Closed Eyes. In the study participants participated in dart throws in two conditions- i) the eye-opened and ii) eye- closed along with recording of the kinematics of the throwing hands. Participants consisted of 15 students and staff while data of the two of the participants were removed from the study due to technical errors during data registration. therefore, final number of the subjects were13. Results revealed that compared to peripheral throws, the position of the hand while throwing the darts was in its raising phase was closer to the torso when performing more accurate throws with the eye-opened conditions.

Yuan, L., Xu, T.L., Yu, C., & Smith, L.B. (2019) study examined whether changes in manual behaviour alter toddlers' eye gaze by giving one group of children heavy toys that were hard to pick up, while giving another group of children perceptually identical toy that were lighter easy to pick up and hold. Result revealed that found a tight temporal coupling between the dynamics of visual attention and the dynamics of manual activities on objects, a relation that cannot be explained by interest alone.

Wu, J., Chan, J. S. Y., & Yan, J. H. (2018) conducted a study on Movement Segmentation and Visual Perturbation Increase Developmental Differences in Motor Control and Learning. Participants included One hundred and five participants (53 female) were divided into three age groups (7 to 8 years, 9 to 10 years and 19 to 27 years). They performed a two-segment movement task in four conditions (full vision, fully disturbed vision, disturbed vision in the first movement segment and disturbed vision in the second movement segment). The results revealed for movement accuracy and overall movement time show that children, especially younger children, are more susceptible to visual perturbations than adults.

Rienhoff, R., Hopwood, M. J., Fischer, L., Strauss, B., Baker, J., & Schorer, J. (2013) administered a study on Transfer of Motor and Perceptual Skills from Basketball to Darts. The sample comprised of T13 skilled and 13 less-skilled male basketball players participated in this experiment. The study attempted to replicate previous skill-based differences in quiet Eye-investigated whether transfer of motor and perceptual skills occurs between similar tasks. Finding suggested that Skilled basketball players showed significantly higher throwing accuracy and longer quiet eye duration in the basketball free throw task compared to their less-skilled counterparts.

Crippa, A., Forti, S., Perego, P., & Molteni, M. (2012) investigated a study on Eye-hand coordination in children with autism spectrum disorders (ASD) in comparison with age-matched normally developing peers. The Eye-hand correlation was measured by putting fixation latencies in relation with pointing and key pressing responses in visual detection tasks where a gap-overlap paradigm was used and compared to fixation latencies in absence of manual response. Finding suggested that ASD patients showed less efficient Eye-hand coordination, which was particularly evident when pointing towards a target was being fixated.

Grigore, V., Mitrache, G., Predoiu, R., & Roşca, R. (2012) investigated Characteristics of Instrumental Movement-Eye-hand Coordination in sports. The computerized test TUD (Dynamic Tracking), developed by RQ Plus, is conceived as a dynamic model obtained through the constant or unsteady movement of a target in a delimited space. The sample consisted of 127 athletes, who participated through direct contact (handball, basketball, karate) or no contact (gymnastics, dance, athletics, and swimming). Results revealed that using t test, significant differences between subjects were identified, statistically-wise ($p < 0,05$), concerning Eye-hand coordination.

Paul, M. Biswas, S.K., & Sandhu, J. S. (2011) examined a study on the effects of sports vision and Eye-hand coordination, training sensory and motor performance of table tennis players. The experimental group was given 8 weeks of sports vision and Eye-hand coordination training while control group didn't receive any training. Result found that playing tennis improves the visual skills as well as Eye-hand coordination in experimental group than control group. Therefore, cup-stacking found to be effective in enhancing Eye-hand coordination and reaction time.

Masia, L., Casadio, M., Sandini, G., & Morasso, P. (2009) administered a study on Eye-hand Coordination during Dynamic Visuomotor. As per the study for many technology-driven visuomotor tasks such as tele-surgery, human operators face situations in which the frames of reference for Eye-coordination are misaligned and need to be compensated in order to perform the tasks with the necessary precision. The cognitive mechanisms for the selection of appropriate frames of reference are still not fully understood. This study investigated the effect of changing visual and kin-aesthetic frames of reference during wrist pointing, simulating activities typical for tale-operations.

Lazzari, S., Mottet, D., & Vercher, J.-L. (2009) explored a study on Eye-hand Coordination in Rhythmical Pointing. This study carried out to investigate whether there is relationship between hand kinematics and eye movements in 2 variants of rhythmical Fitts's task in which eye movement is necessary or not necessary**.** A sample size was 6 men and 1 woman at the age group of 24-42 years. Result revealed that Movement continuity and eye–hand synchronization were more directly related to movement time than to task index of difficulty. When movement time was decreased to fewer than 350ms, eye–hand synchronization switched from continuous monitoring to intermittent control.

Udermann, B. E., Mayer, J. M., Murray, S. R., & Sagendorf, K. (2004) investigated a study on Influence of cup stacking on hand-eye coordination and reaction time of second-grade. The sample size were 24 girls and 18 boys who were measured by soda pop Pop and Yardstick tests along with two physical education classes who were randomly selected as an experimental and control groups. Both the groups were given pr and posttest for Eye-hand coordination and reaction time and intervention were given to the treatment group for 5weeks. Results highlighted that there was significant improvement for both Eye-hand coordination and reaction time between pre- and posttest

Johansson, R. S., Westling, G., Bäckström, A., & Flanagan, J. R. (2001) explored a study on the Eye-hand Coordination in hand Manipulation. A sample consisted of four women and five men between 22 and 52 years of age participated in the experiments. The researcher analysed the coordination between gaze behaviour, fingertip movements, and movements of the manipulated object when subjects reached for and grasped a bar and moved it to press a target-switch. Result found that gaze supports hand movement planning by marking key positions to which the fingertips or grasped object are subsequently directed. The salience of gaze targets arises from the functional sensorimotor requirements of the task. The gaze control contributes to the development and maintenance of sensorimotor correlation matrices that support predictive motor control in manipulation.

Carmody, D. P. (2001) conducted a study on Spatial Orientation Adjustments in Children with Autism in Hong Kong. A sample comprised of 24 children diagnosed with autism from Kowloon, Hong Kong was assessed for spatial orientation and spatial management abilities. Positive changes in spatial orientation were evident when the children wore ambient prism lenses and included changes in posture from slanted to erect. Adjustments in spatial management were evident in improved ball catching ability, a task requiring visual tracking and Eye-hand coordination. The findings suggested that alterations to the sensory systems may lead to behavioural change in some children.

Badan, M. (2000) investigated a study on Sequential Pointing in Children and Adult. A sample size was 50 boys who were divided into five equal age groups (6, 7, 8, 9, and 10 years) and 10 male adults (mean age 32 years) volunteered for the experiment. In 3 experiment tasks was manipulated based on difficulty by changing the number, the size, and the spacing of the targets in the sequences. In Experiment 4, only 1 movement was required; varied independently the distance between targets and the distance of the starting point from the participant's body. Result found that Children's temporal and spatial parameters of the motor sequences showed large age dependent trends, but did not reach the adult values. Comparison of performance across levels of difficulty and ages suggests that motor development is not a uniform fine-tuning of stable strategies. Each stage of development is best characterized by the set of strategic components potentially available at that stage, and by the (age dependent) rules for the selection of components in a given context.

Literature review on Game of Darts

Van der Loo, J., Krahmer, E., & van Amelsvoort, M. (2020) administered study on Learning How to Throw Darts. Effects of Modelling Type and Reflection on Novices' Dart-Throwing Skills. The sample size consisted of 156 participants from university and high school who were randomly assigned to enhance the generalization. A 3 x 2 design was used in this experiment, with modelling type (novice model, expert model and no model) and reflection (yes or no) as the between-subjects factors which were carried out in 6 conditions. Pre-test and post-test were conducted. Post-test was given after modelling intervention. Result suggested that no effect of modelling type and reflection were found. There was no interaction effect. There was improvement in dart-throwing skills, self-efficacy beliefs, and self-reaction scores over time.

Samsudin, N. A., & Low, J. F. L. (2017) proposed a study on the effects of different focus of attention on throwing skills among autistic spectrum disorder children. The sample size consisted of 10 boys with autism spectrum disorder aged from seven to 10 from a Special Education government school located in middle-class communities in Penang, Malaysia was randomly assigned into two groups that is external focus and internal focus. The EF group were instructed to throw the boules so that it moved in a parabolic trajectory as if they were "creating a rainbow" while the IF group were instructed to throw techniques, concentrating on the mechanics of the throwing arm during a two intervention. Result found that there was significant difference between pre-test and post-test among both groups on ANOVA. EF group performed better than If group in the Posttest.

Razeghi, R., Nia, P.S., Bushehri, N.S., & Maleki, F. (2011) conducted a study on Effect of interaction between Eye-hand dominance on dart skill. The sample size comprised of 20 males in the age group of 21 years old from University of Shahid Chamran who were divided into two groups. Each group consisted of 10 males. Group one included subjects who were unilateral (right Eye-right hand or left Eye-left hand) and group two belonged to those who were cross lateral (right Eye-left hand or left Eye-right hand) group. Both the groups received training in the same conditions for 12 sessions. Subjects were asked to throw 60 darts in each session. The acquisition test and the retention test were developed and scores on the pre-test of both the tests were recorded. Porta (Roth, 2002) and Hole in the card test (Sage, 1984) was used to select eye dominance and Edinburgh questionnaire (Oldfield, 1971) was used to determine handedness. The result found that there was a significant difference between the pre-test among both the groups after training session on acquisition and retention tests on dependent paired t-test analysis where as independent t-test showed that there was no significant difference among both the groups on acquisition and retention tests. Findings suggested that interaction between hand and eye dominance does not affect dart skill.

Methodology

The methodology of the proposed research work includes population, sample and sampling technique, research design, development of the tool, data collection procedure, intervention, processing of data and plan for data analysis. This study has been conducted at NIEPMD to examine the outcome and evaluation of game of darts on enhancing eye-hand coordination for children with autism spectrum disorder. The samples were selected at NIEPMD model school and from Department of Special Education Services.

Sample Selection and Description

Five children with autism spectrum disorders individuals who attend a NIEPMD model school and Special Education served as participants. The centre offers self-help, social/communication, and vocational skill training to 5 severely and profoundly handicapped persons between 6 and 14 years of age.

The clients attend the centre from 9:00 a.m. to 3:00 p.m. Monday through Friday. The darts skill leisure training program was initiated in the special education service within the campus.

Table 3.2 (a) Demographic details of the data

Participants	Age	Criteria	Locality
Subject 1	9	ASD	rural
Subject 2	6	ASD	urban
Subject 3	11	ASD	urban
Subject 4	13	ASD	rural
Subject 5	14	ASD	rural

Description about the subjects:

Subject 1 was a 9-yr-old male was involved in the study. He had autism spectrum disorder and an unsteady, uncoordinated gait with poor dynamic and not stable within one place. He had difficulty in the visual tracking of moving objects. Communication and social lack. Subject 1 communication skills reflected the ability to follow multiple step directions, although he was minimally verbal. Subject 1 had problem in Eye-hand coordination skill repertoire consisted of rarely coordinate sound and light movements and not able to concentrate on one activity, he is having problem with cooperating with peer group and others also.

Subject 2 was 6-yr-old male. he had autism spectrum disorder with behaviour issues in between activity, and poor eye contact with the activity sometimes poor Coordination in His activity involvement. Subject 2 spoke in short phrases but not in sentences.

Subject 3 was a 11-yr-old male. He had autism spectrum disorder. His behavioral functioning was described as "autistic," since he frequently exhibited perseverance, self-stimulatory motor movements and other stereotopic behaviour (e.g., body rocking, placing hands in front of face, staring aimlessly). His speech consisted exclusively of delayed echolalia and spontaneous verbal behaviour was non-existent. He did not engage in any leisure related activity.

Subject 4 was a 13-yr-old male. He had autism spectrum disorder. School staff reported that subject 4 had yet to maintain or generalize any behaviour that he had acquired within 5 YEAR of attendance at the NIEPMD model school (primary and secondary). His speech consisted exclusively of delayed and spontaneous verbal behaviour was non-existent. He can engage in any leisure related activity like painting, drawing. he was having good concentration skill but lack in social relationships, peer group and also in Eye-hand coordination.

Subject 5 was a 14-yr-old male. He had autism spectrum disorder. school staff reported that subject 5 had yet to maintain or generalize any behaviour that he had acquired within 1year of attendance at model school from NIEPMD. His speech consisted exclusively of delayed echolalia and spontaneous verbal behaviour was non-existent. Engage in any leisure related activity dancing. He was having problem in behavioral issues and Eye-hand coordination.

Inclusion criteria

The children who met the ICD-10 criteria for the making diagnosis of autism spectrum disorder and ID and those attending special school were included.

Exclusion criteria

The children with serious physical, mental problem, and children with chronic neurological conditions such as cerebral palsy, epilepsy etc. were excluded.

Conceptual Framework

Individuals with Autism Spectrum Disorder (ASD) have difficulty in concentrating on task within classroom setting. It is important to enhance Eye-hand coordination in outdoor environment though it is a recreational activity the autistic children will enjoy and performing the task easily.

Paul.M, Biswas, Sandhu (2011) supports that suggest that playing tennis is improving the visual skills and Eye-hand coordination.

Hence lack of attention and concentration with Children with Autism Spectrum Disorder the main focus is to improve their focus and Eye-hand coordination.

The objective of this study is to find the effectiveness of game The objective of this study is to find the effectiveness of game of darts among children with autism spectrum disorder to improve Eye-hand coordination.

Experimental method will be carried out.

Purposive sampling of non-probability sampling will be carried out.

The sample is from NIEPMD model school.
Sample size: 5
Target group:6 to 14 years of ASD unit.

Variables
Independent variable: game of darts
Dependent variable: Eye-hand coordination

Pilot study
Tool appropriateness
Pre-test evaluation
Intervention post-test

20-30 minutes is given to the group which are assessed periodically.

Data is collected with the information consent and permission from the school

The conclusion is to drawn based on the effects of game of darts.

Tool Used:
Consent Form:

Each parent was given informed assent form to seek willingness to participate to target study sample is between 6-14 years. It contained the information regarding the name of the study, details of the investigator, description of the study and the clauses stating confidentiality. The consent form also induced the nature and purpose of the study.

Tool 1: Personal profile

This tool contains certain socio-demographic variables to elicit personal information from the participants such as age, gender, and level of disability, urban or rural and their family history.

Tool 2: Prerequistics rating scale

The researcher developed a tool to observe the prerequisite skill of children with Autism Spectrum disorder during pretest and posttest.

Instrumentation:

For the purpose of conducted the research the investigator used a scoring sheet and a kit. Included as rating scale for assessing the level of Eye-hand coordination of children with autism spectrum disorder (appendix B). This scoring sheet was developed by researcher for the purpose of teaching children with ASD. It consists of 4 domains. The tool was constructed with 25 items comprising of three domains namely social skills needed at home, school, sports / game place. The scoring procedure is included 4-point rating scale, score procedure is 1- Never, 2 – Rarely, 3 – sometimes, 4 – Always.

Rating scale for measure Eye-hand co-ordination:

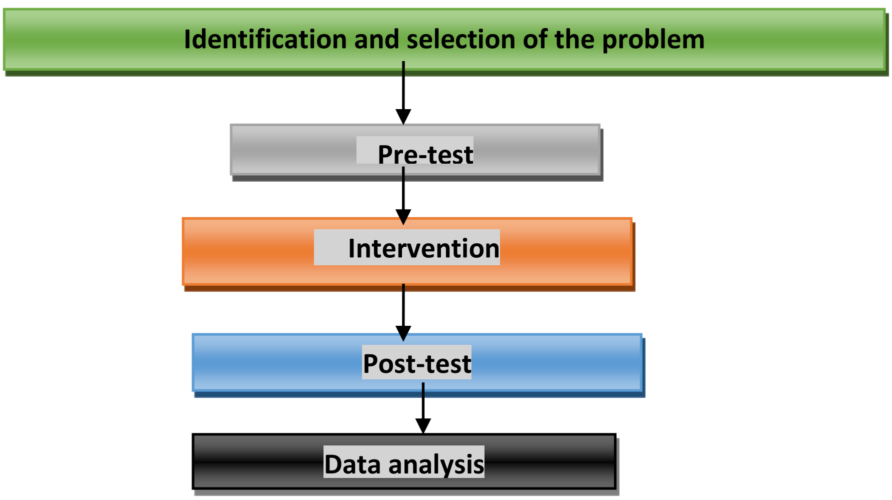
High agreement items were pooled together and the scoring sheet was prepared (APPENDINX - B). For research evaluating during pre-test and post- test. Code during the performance was given as 1- Never, 2 – Rarely, 3 – Sometimes, 4 – always. The scoring sheet consisting 15 items of to develop an Eye-hand coordination administered with special educators to establish validity of the scoring sheet. It was found that there was high agreement to teach all the 15 items by indicating it to be highly appropriate.

Tool 3: **Progress monitoring sheet: this tool was used** to measure the performance of Children with Autism Spectrum Disorder from the throwing distance of 1m, 2m and 3m. the progress monitoring was administered once in every two weeks. The Progress Monitoring sheet includes Baseline data, progress monitoring 1, progress monitoring 2, progress monitoring 4 and final. the tool 3 is appended in the appendix 3.

Research design:

The study is an experimental research design; the researcher assigned 5 children in the experimental group.

Data Gathering Procedure



Data collection procedure:

The prior informed consent was obtained from the parents to involve the subject in the study. Parents were explained in the regional language about the purpose of the study, intervention plan, expected outcome. The test procedure was explained and demonstrated in detail.

Pretest score was collected using direct observation of the subject taken in the study before the intervention. Posttest was conducted after the intervention for a period of 3 months of 3 days in a week. Intervention given to selected sample for about 30 minutes per day.

The implementation of intervention steps are as follows:

1. Initially, the intervention given to improve the skill of throwing
2. Task analysis
3. Through this intervention program, children were made aware of the social skills, communication skills, greeting others etc. appropriate coordination and object manipulation was used in the game for their active involvement
4. Baseline Initially a non-reinforced baseline was conducted to determine pre-instruction (PRE-TEST) competency levels. The baseline level for each participant was derived by giving the verbal cue (i.e., " subject 1, subject 2, subject 3, subject 4, subject 5, throw the darts at the board."), and recording the steps of the scoring sheet (15 items) performed correctly and with assistance.

Subject 1,2,3,4,5 within the autism spectrum disorder, were assessed on 30 sessions (Intervention) respectively. The general verbal cue was given and the number of steps performed independently recorded. Instruction began on the next step of the task analysis which had not been performed correctly or without assistance during two consecutive sessions. An instructional cue hierarchy (Horner & Keilitz, 1975) was used to teach the dart skills.

Intervention method:

The objective of the dart skills was for each participant to throw three darts (3 TERM) and to strike the dart board successfully on each toss from the standard 10 ft (3M). distance. Criteria for mastery consisted of 100% completion of the 7-step task analysis for Two consecutive sessions.

An additional objective of the program was to generalize dart throwing performance to 2 other environments (i.e., class room setting and resource room set up) and across time (i.e., 3-month follow-up). The goal of the generalization probes was to demonstrate criterion level performance in several environments using physical prompt, verbal prompt, gesture prompt, cue prompt.

Given a dart board at standard height and three darts, the participants will strike the dart board from the standard 10 ft (3m) distance, 100% of the time. The original verbal cue given to each participant was "(subject 1, subject 2, subject 3, subject 4, subject 5), throw the darts at the board." The seven steps of the task analysis in the correct sequence were

(a) stand/sit 10' from dart board, (INITIAL 1m, NEXT 2m, FINALLY 3m)
(b) Grasp first dart in dominant hand (tip of dart facing board) using pincer grasp,
(c) Bend elbow until forearm is perpendicular to ground,

(d) Thrust forearm and hand in forward motion toward board, releasing dart when arm is extended,
(e) First dart strikes dart board,
(f) Throw second dart, striking dart board, and
(g) Throw third dart, striking dart board.

Data analysis

The data collected from the experimental study was put into a form as a table in excel sheet. These collected data were statistically analyzed to investigate the relationship between the variables. Analysis of the study was done by the using IBM SPSS software version 2.0. With the help of descriptive statistical analysis, the collected quantitative data was analyzed. This analysis includes calculating Mean and the Standard Deviation of the pre-test and the post-test scores. The pre-test and the post-test score was compared to draw conclusions about the findings. To organize the findings in effective simple way of meaningful communication the investigator used graphical tools like bar charts and histograms were shown on further chapters.

Result and Dicussion:

An outline of a few methods in an emerging field of data analysis, "data interpretation", is given as pertaining to Eye-hand coordination and being parts of a autism spectrum disorder issue. Specifically, the following subjects are covered: Measuring correlation between socio-data categories, conceptual clustering, and generalization and interpretation of empirically derived concepts in game of darts. It will be shown that all of these can be put as parts of the same inquiry. It is the process of collection, analyzing and interpreting and numerical data. This chapter deals analysis and interpretation of the collected data for the research. The results of the present study were discussed as follows,

1. Effectiveness of game of dart in improving Eye-hand coordination among children with ASD
2. Effectiveness of game of dart in improving Eye-hand coordination among children with ASD with respect to socio - demographic data (age, locality)
3. progress of score improving Eye-hand coordination among children with ASD in different distance(1m, 2m, 3m). (Descriptive Analytical Method)

Effectiveness of game of dart in improving Eye- hand coordination among children with ASD:

Table 4.1 Mean, Standard Deviation and t- value of Pre-Test and Posttest scores.

Domain	N	Mean	SD	't' value	Sig
Pretest	5	38.20	1.483	-17.493	0.00
Posttest	5	48.40	1.817		

Table 4.1 Shows the Mean, standard deviation, t-value of pre-test and post-test performance of children with autism spectrum disorder. It was inferred from the table that the overall pre-test mean is 38.20 post-test mean 48.40. It indicates t value is -17.493 and p value is 0.00 which is significant at 1 % level. Therefore the hypothesis Effectiveness of game of dart in improving Eye-hand coordination among children with ASD is rejected. Hence it is concluded that game of darts improves the Eye-hand coordination among children with Autism Spectrum Disorder.

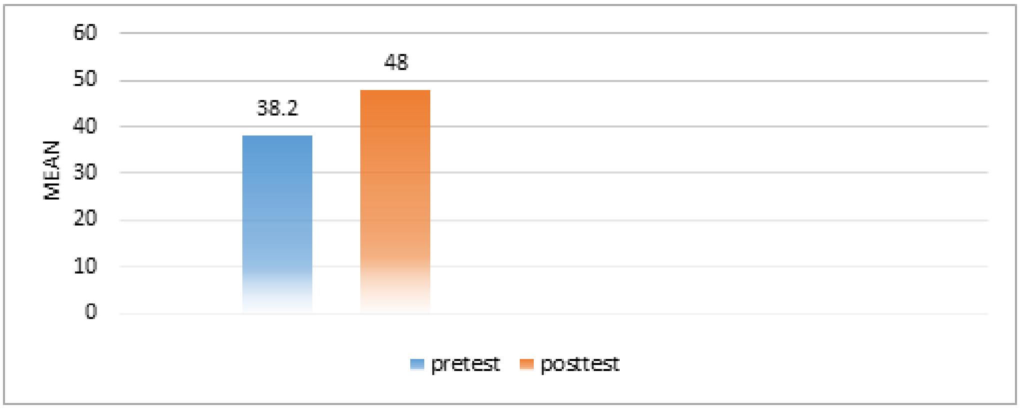


Figure 4.1: Mean score on overall performance of improving Eye-hand coordination in Children with Autism Spectrum Disorder

Effectiveness of game of dart in improving Eye-hand coordination among children with ASD with respect to Socio-demographic data (age, locality):

Table 4.2 (a) Mean, Standard Deviation t- value of Pretest and Posttest performance of Eye-hand coordination in children with autism spectrum disorder with reference to Age

	Age	N	Mean	S.D	Df	't' value	Sig
Pretest	Below 10	2	38.5	0.7	3	0.39	0.938
	Above 10	3	38.0	2.0	2.6		
Posttest	Below 10	2	48.5	2.1	3	0.08	
	Above 10	3	48.3	2.1	2.2		

From **Table** 4.2(a) it is found that the mean score of children with autism spectrum disorder between below 10 and above 10 with regard to Eye-hand coordination in children with autism spectrum disorder pretest values are 38.5, 38.0 and posttest values are 48.5, 48.3. The SD values of pre-test are 0.7 and 2.0, post-test values are 2.1 and 2.1 respectively. The t-value found to be pre-test is 0.4 and posttest is 0.935 and the 'p' value is 0.9 which is not significant at 5%. Therefore, the null hypothesis is accepted. Hence the null hypothesis, there is no effectiveness of game of dart in improving Eye-hand coordination among children with Autism Spectrum Disorder with respect to age is accepted. Hence it is concluded that game of darts did not influence the Eye-hand coordination among children with Autism Spectrum Disorder with respect to age.

From this we can interpret that there is no significant in varying age groups of children autism spectrum disorder in learning Eye-hand coordination. There is a significant improvement in learning Eye-hand coordination in children with autism spectrum disorder with references to age.

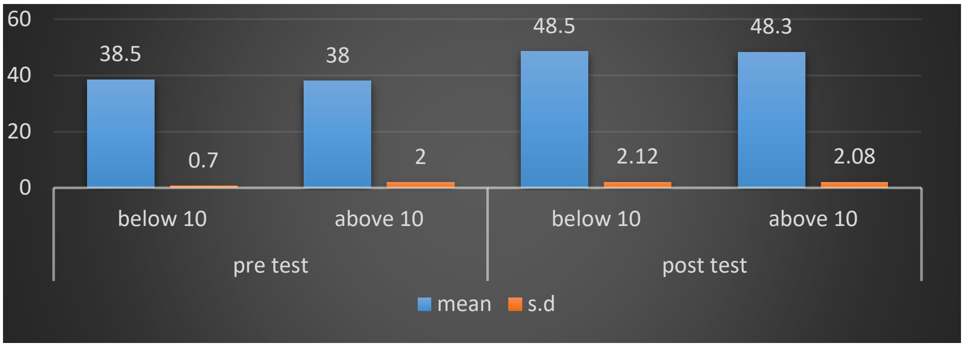


Figure 4.2 (a): Mean score on improving Eye-hand coordination among Children with Autism Spectrum Disorder with reference to age.

Table 4.2 (b) Mean, Standard Deviation t- value of Pretest and Posttest performance of Eye-hand coordination in children with autism spectrum disorder with reference to locality

	Locality	N	Mean	S.D	't' value	sig
Pretest	Rural	3	41	3.6	1.43	
	Urban	2	37	1.4	1.73	
Posttest	Rural	3	49.6	0.5	5.56	
	Urban	2	46.5	0.7	5.27	0.38

From **Table** 4.2 it is found that the mean score of children with autism spectrum disorder between rural and urban with regard to Eye-hand coordination in children with autism spectrum disorder Pretest values are 41, 3 and Posttest values are 49.6, 46.5. The SD values of pre-test are 3.6 and 1.4, post-test values are 0.5 and 0.7 respectively. The t-value found to be pre-test is 1.43, 1.73 and Posttest is 5.56, 5.27. The significant value is 0.38 which is non significant at 5% and null hypothesis is accepted. Therefore is no significant difference in improving Eye-hand coordination for children with autism spectrum disorder with respect to locality. From this we can interpret that there is no significant in varying age groups of children autism spectrum disorder in improving Eye-hand coordination. There is a significant improvement in Eye-hand coordination in children with autism spectrum disorder with references to age.

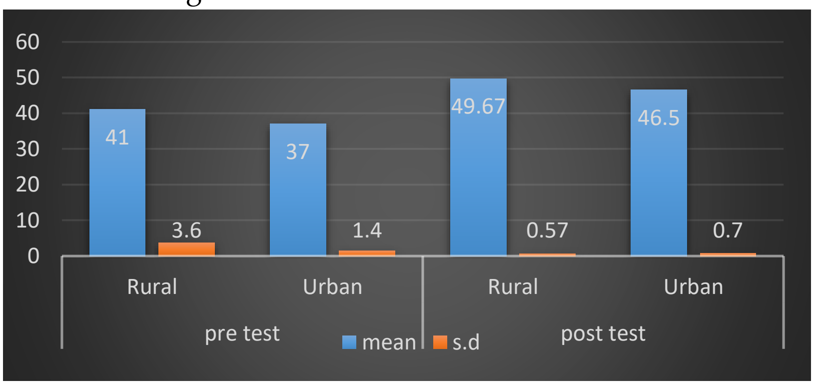


Figure 4.2 (b): on improving Eye-hand coordination in Children with Autism Spectrum Disorder with reference to locality.

Progress monitoring of score improving Eye-hand coordination among children with ASD in different distance(1m, 2m, 3m).

Table 4.4 (a) progress of score improving Eye-hand coordination among children with autism spectrum disorder in two weeks once. (1 mt)

Subjects / assessment dates in 1 mt	Baseline	Progress 1	Progress 2	Progress 3	Progress 4	Final
Subject 1	1	1	2	2	3	3
Subject 2	0	1	1	2	2	2
Subject 3	0	1	1	1	1	2
Subject 4	1	1	2	1	3	3
Subject 5	1	1	2	2	3	3

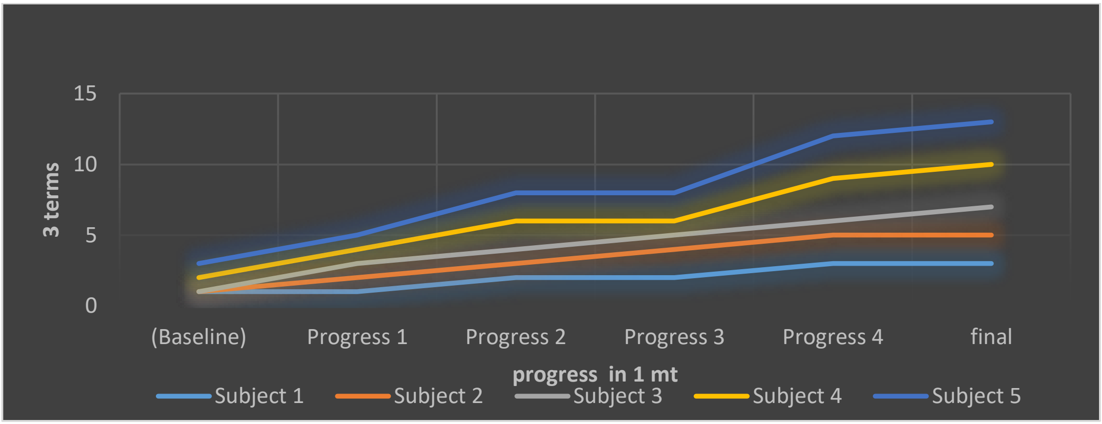


Figure 4.4 (a): Progress score from throwing distance (1mt)

From table 4.4 (a) displays that subject and subject 4 were able to dart correctly on distance 1 metre. It indicates that the subject 1 has shown the difficulties in playing the dart game , may be due to the reason that children with ASD may have positional and attention issues while playing dart of game. The researcher is not calculating with their circle dart hitting points. Subject 5 were able to dart correctly from distance 1 meter.

Baseline from **fig 4.4.(a)** end of the course its showing gradually increased the performance. Subject 4,5 is having more concentration on the game and showing Eye-hand coordination is in good level. Consider the progress of subject 3 was concentrate over period of time may be due to period of time, he is having more distraction from the outsource so graph is showing moderate growth in eye coordination of children with ASD.

Table 4.4 (b) progress of score improving Eye-hand coordination among children with autism spectrum disorder at 2 mt distance

Subjects / assessment dates in 2 mt	(Baseline)	Progress 1	Progress 2	Progress 3	Progress 4	Final
Subject 1	0	1	1	2	1	2
Subject 2	0	1	1	2	2	2

Subject 3	0	0	1	1	1	1
Subject 4	1	1	2	1	2	3
Subject 5	1	1	2	2	2	3

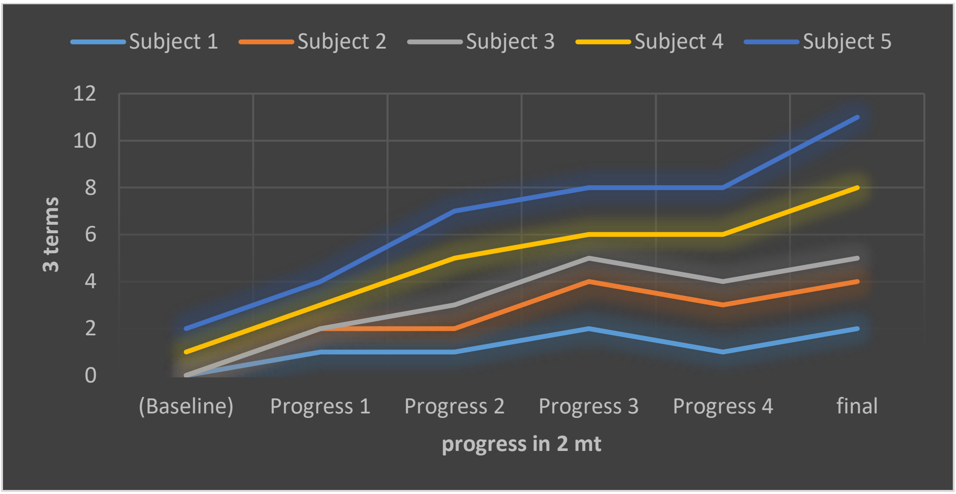
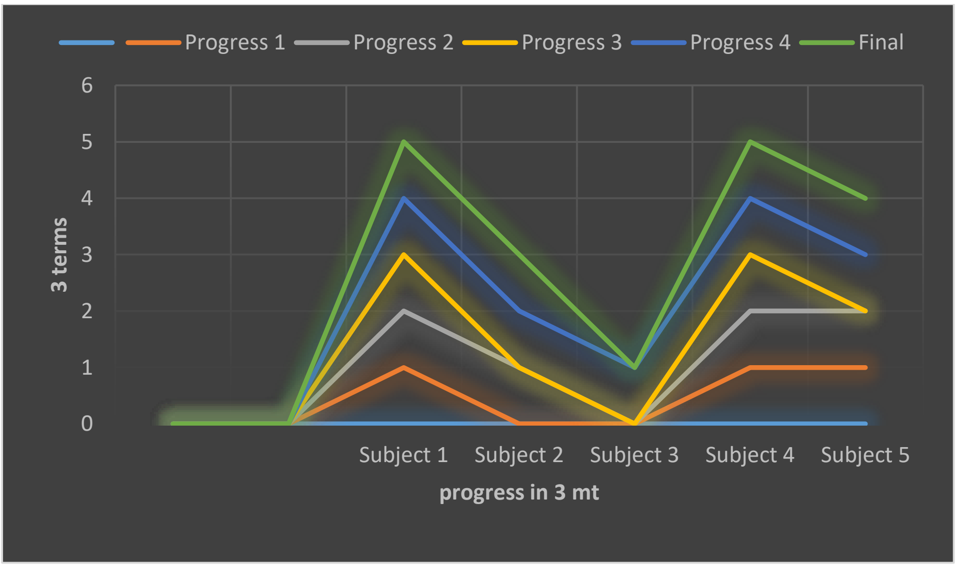


Figure 4.4 (b): Progress of score in improving Eye-hand coordination among children with autism spectrum disorder at 2 mt distance

From this **Table 4.4 (b) displays the G**ame of darts in improving Eye-hand coordination for children with ASD in 2 meter distance. Comparing with distance of 3m, 1m and 2m showing improvement in Eye-hand coordination. Children with ASD having problem with body position and concentrating on game, poor attention to the dart board while increasing distance up to 2m. Consider the progress of subject 3 was able to focus over period of time even though the subject 3 has difficulty in maintain a standing position and play the dart game in more distance.



From the above 4.4 (b) figure, display the game of darts in improving Eye-hand coordination for children with ASD in 2 m distance. It was shown that the performance increases from Baseline to the end of the course. It reveals that Subject 4 and 5 improved performance in comparision with subject 2 , 3 and respectively.

The subjects varies with individual characteristics as described in the sample wise description. Consider the progress of subject 3 was concentrate over period of time may be due to period of time, subject 2 may having more distraction from the outsource so graph is showing moderate growth. Subject 1, 3 also may having behavioral issues on playing game of darts time.

Table 4.4 (c) progress of score improving Eye-hand coordination among children with autism spectrum disorder at 3 mt distance

Subjects / assessment dates in 3 mt	(Baseline)	Progress 1	Progress 2	Progress 3	Progress 4	Final
Subject 1	0	1	1	1	1	1
Subject 2	0	0	1	0	1	1
Subject 3	0	0	0	0	1	0
Subject 4	0	1	1	1	1	1
Subject 5	0	1	1	0	1	1

Figure 4.4 (c): Progress score in improving Eye-hand coordination among children with autism spectrum disorder at 3 m distance

From **table 4.4 (c) and fig 4.4** subject 1 and subject 2 were able to dart correctly from 1m and 2m than comparing with the distance of 3m. It indicates that the subject 3 has shown the difficulties in playing the dart game , may be due to the reason that children with ASD may have positional and attention issues while increasing distance to 3m. From the above fig.4.4 displays Game of darts in improving Eye-hand coordination among children with ASD in 3 meter distance. The intervention helped them to improve in Eye-hand coordination. From the fig indicates there is gradual increase in performance of children with ASD from baseline to final. Comparing the performance of subjects 4, 5 has greater achievement than the other subjects. From the fig indicates only subject 3 has the lower performance due to the reason that the children with ASD has markable amount of behavioural issues.

Discussion:

Effectiveness of game of dart in improving Eye-hand coordination among children with ASD

Results obtained through the statistical analysis shows that there is influence of game of dart in improving Eye-hand coordination for children with autism spectrum disorder. It agrees with the literature.

On considering the Effectiveness of game of dart in improving Eye-hand coordination among children with ASD with respect to socio - variables (age, locality). It was inferred that there is no significant difference in improving Eye-hand coordination with respect to age and locality in this study. This is in line with the the literature of Bairi, F., Farsi A., Abdolo, B., & Kavyani M. (2020) who examined study on The Effect of Visual and Tennis Training on Perceptual-Motor Skill and Learning of Forehand Drive in Table Tennis Players.

Recommendations of the research study

1. The effect of game of darts for improving Eye-hand coordination among children with autism spectrum disorder is relatively new concept in autism spectrum education in India hence this study can be incorporated in curriculum to improve the Eye-hand coordination among children with autism spectrum disorder.
2. General teachers, special educators and other professionals can introduce the Recreational activity for children with Autism Spectrum Disorder.
3. The awareness can be created among parents and special educators to play game of dart in order to improve the Eye-hand coordination.
4. The study recommended for all ages since it is beneficial in the areas such as attention, concentration and self confidence.

Suggestion for further research:

1. The study has involved the age group of 6 to 14 years of age. Further studies can be taken on varying age group of children with autism spectrum disorder.
2. This study can also be done with autistic children having sensory issues and other disability for improving Eye-hand coordination.
3. This further studies can be done with large number of samples. And then the study can be generalized.
4. Studies can be done on the basis of the severity of condition of children with autism spectrum disorder.
5. Studies can be extended to various schools since the present study focused upon only one school.
6. In future, studies can be conducted for children with other disabilities too for improving Eye-hand coordination.

Conclusion

The Present study is concluded that game of darts training intervention improves the Eye-hand coordination among children with autism spectrum disorder. Further addition to that it can be support to increase in concentration, socialization skills and communication. Further this can be extended in academic areas for improvement for learning mathematics. Eye-hand coordination is the skill necessarily coincided for children at early age development. This research study has baseline for further research to enhance the visual motor skills as it s beneficial to children with ASD for their overall development.

References:

1. Amado Sanchez, V. L., Islas Cruz, O. I., Ahumada Solorza, E. A., Encinas Monroy, I. A., Caro, K., & Castro, L. A. (2017). *BeeSmart: A Gesture-Based Videogame to Support*

Literacy and Eye-hand Coordination of Children with Down Syndrome. Games and Learning Alliance, 43–53. doi:10.1007/978-3-319-71940-5_4 Retrieved at https://sci-hub.do/10.1007%2F978-3-319-71940-5_4

2. Badan, M., Hauert, C.-A., & Mounoud, P. (2000). *Sequential Pointing in Children and Adults. Journal of Experimental Child Psychology, 75(1), 43–69.* doi:10.1006/jecp. 1999.2522 Retrieved at https://sci-hub.se/10.1006/ jecp.1999.2522
3. Binsted, G., Chua, R., Helsen, W., & Elliott, D. (2001). *Eye–hand coordination in goal-directed aiming. Human Movement Science, 20(4-5), 563–585.* doi:10.1016/s0167-9457(01)00068-9
4. Retrieved at https://sci-hub.se/10.1016/s0167-9457(01)00068-9
5. Carmody, D. P. (2001). *Child Psychiatry and Human Development, 31(3), 233–247.* doi:10.1023/a:1026481422227
6. Retrieved at https://sci-hub.do/10.1023%2Fa%3A1026481422227
7. Crippa, A., Forti, S., Perego, P., & Molteni, M. (2012). *Eye-hand Coordination in Children with High Functioning Autism and Asperger's Disorder Using a Gap-Overlap Paradigm. Journal of Autism and Developmental Disorders, 43(4), 841–850.* doi:10.1007/s10803-012-1623-8
8. Retrieved at https://sci-hub.se/10.1007/s10803-012-1623-8
9. Grigore, V., Mitrache, G., Predoiu, R., & Roşca, R. (2012). *Characteristic of instrumental movements – Eye-hand coordination in sports. Procedia - Social and Behavioral Sciences, 33, 193–197.* doi:10.1016/j.sbspro.2012.01.110 retrieved from
10. Retrieved at https://sci-hub.se/10.1016/j.sbspro.2012.01.110
11. Idris, TgMalim, Perak *the effect of different focus of attention on throwing skills among autism spectrum disorder:Pulau Pinang Education Department, Bukit* **.**
12. Retrieved at https://sci-hub.se/10.4314/jfas.v9i6s.96
13. Johansson, R. S., Westling, G., Bäckström, A., & Flanagan, J. R. (2001). *Eye–Hand Coordination in Object Manipulation. The Journal of Neuroscience, 21(17), 6917–6932.* doi:10.1523/jneurosci.21-17-06917.2001
14. Retrieved at https://sci-hub.se/10.1523/JNEUROSCI.21-17-06917.2001
15. Lazzari, S., Mottet, D., & et al, J.-L. (2009). *Eye-hand Coordination in Rhythmical Pointing. Journal of Motor Behavior, 41(4), 294–304.* doi:10.3200/jmbr.41.4.294-304
16. Retrieved at https://sci-hub.se/10.3200/jmbr.41.4.294-304
17. Masia, L., Casadio, M., & et al, P. (2009). *Eye-hand Coordination during Dynamic Visuomotor Rotations. PLoS ONE, 4(9), e7004.* doi:10.1371/journal.pone.0007004
18. Retrieved at https://sci-hub.se/10.1371/journal.pone.0007004
19. Rienhoff, R., Hopwood, M. J., Fischer, L., Strauss, B., Baker, J., & Schorer, J. (2013). *Transfer of motor and perceptual skills from basketball to darts. Frontiers in Psychology, 4.* doi:10.3389/fpsyg.2013.00593
20. Retrieved at https://sci-hub.se/10.3389/fpsyg.2013.00593
21. Schleien, S. J., Wehman, P., & Kiernan, J. (1981). *Teaching leisure skills to severely handicapped adults: an age-appropriate darts game. Journal of Applied Behavior Analysis, 14(4), 513–519.* doi:10.1901/jaba.1981.14-513

22. Retrieved at https://sci-hub.se/10.1901/jaba.1981.14-513
23. Smirnov, A. S., Alikovskaia, T. A., Ermakov, P. N., Khoroshikh, P. P., Fadeev, K. A., Sergievich, A. A., … Golokhvast, K. S. (2019). *Dart Throwing with the Open and Closed Eyes: Kinematic Analysis. Computational and Mathematical Methods in Medicine, 2019, 1–10.* doi:10.1155/2019/4217491
24. **Szabo, Neagu, Sopa** ***Eye-hand relationship of proprioceptive motor control and coordination in children 10–11 years old:*** *Vol. 21, no. 3 , 2020, 185–191*
25. Retrieved at thttps://d1wqtxts1xzle7.cloudfront.net/64857479/11_szabo_185_191.pdf?1604562172=&responsecontentdisposition=inline%3B+filename%3DEye_hand_relationship_of_proprioceptive.pdf&Expires=1625734836&Signature=XplBcHL2fZgcpA8N7Sj1OEQ8gviErvxH2nc7VXDQrjg5Hjpp5FGGwGoFcUMa2S99tV8xTHFJE0PqwK8BynMpcun2X0gm19ONn9aKrTDFQ3kdzaAjtE2n0vHBVFB3MAlqcJfMubrH6dgbLIlN171qQJkP7dWRLiVLL9Pc6BvbKmRj33RCUWvvGDTeSyCgQ11BeTYqV8p2MaAPWUhEXEYtw~9jiw74JNE8iuZ7f37BRpmytqOdJXNeccptVlaeVWbwb4Ls11rXhWfSA0f6KTPfFyVt8zkH2ue67gtj4pGK0U~g98hOm9mud5jnyYUtVCEf3McYeqV233YTyPOdjkg__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA
26. Van der Loo, J., Krahmer, E., & van Amelsvoort, M. (2020). *Learning How to Throw Darts. Effects of Modeling Type and Reflection on Novices' Dart-Throwing Skills. Journal of Motor Behavior, 1–12.* doi:10.1080/00222895.2020.1732861
27. Retrieved at https://sci-hub.se/10.1080/00222895.2020.1732861
28. Wu, J., Chan, J. S. Y., & Yan, J. H. (2018). *Movement Segmentation and Visual Perturbation Increase Developmental Differences in Motor Control and Learning. Developmental Science, e12789.* doi:10.1111/desc.12789 https://sci-hub.se/10.1111/desc.12789

QR CODE EMBEDDED TECHNOLOGY-ORIENTED INSTRUCTIONAL STRATEGY FOR IMPROVING FOUNDATIONAL LITERACY SKILLS AMONG STUDENTS WITH INTELLECTUAL DISABILITY

Dr. J. Sujathamalini
Professor & Head
smalinij@alagappauniversity.ac.in

Dr. K. Gunasekaran
Assistant Professor

Mr. G. Ravichandran
Research Assistant RUSA 2.0

Mr. R. Adaikalam
Research Assistant RUSA 2.0

Abstract

This article explored the efficacy of a technology-oriented instructional strategy designed to enhance foundational literacy skills among students with intellectual disabilities. This article objective is to find out the effectiveness of OR Code embedded technology oriented instructional strategy in improving reading comprehension of students with Intellectual disabilities. This study applied the case study method to explore the complex nature of the subject matter. The investigators selected four students with intellectual disabilities for this study for conducting the case study implications process at Alagappa University Special School for Intellectual Disabilities. After implementing the QR Code Embedded Technology-Oriented Instructional Strategy this research found that there exists a significant improvement in the reading comprehension skills of students with Intellectual disabilities.

Keywords: *Technology, Intellectual Disability, OR Code strategy, Reading Comprehension*

Introduction

Technology is becoming part of our daily lives and is a known fact that technology could enhance learning experiences. Investigating innovative teaching methods that could support the development of basic reading skills among children with intellectual disabilities is imperative with the increased use of technology in schools. We can create an engaging and interactive learning setting by using instructional programs and technology resources designed specifically for students with intellectual disabilities (Sari et al., 2018).

This approach tries to solve the issues that students with intellectual disabilities have in reading when they are developing their reading skills and responding to their unique learning requirements.

The Importance of Contextualized Learning

Contextualized learning is an important element of successful literacy education for students with intellectual disabilities. It recognizes that students with intellectual disabilities may have trouble with abstract concepts and would appreciate concrete, real-life illustrations (Sari et al., 2018). The motivation and overall performance of students in reading and writing can be increased by providing them with context, through which they are able to understand the significance and worth of literacy skills (Wilson & Hunter, 2010). The key to the promotion of literacy in intellectually disabled students is through the inclusion of participatory and communicative tasks. As per Sari et al. (2018), such activities provide students with an opportunity to engage positively in their studies, engage in meaningful discussion, and improve their reading skills.

Exercises such as interactive narratives, online reading groups, and collaborative writing assignments may be included in this category. Integrating technology in these exercises can enhance student engagement and provide additional support, such as auditory prompts or visual cues, to accommodate different learning styles and ability levels (Pandya & Ávila, 2016). Moreover, the use of instruction that involves multiple senses can enhance the learning experience of people with intellectual disabilities (Wilson & Hunter, 2010). As Sari et al. (2018) state, this might mean providing children with an opportunity to be creative in expressing themselves through writing or drawing, using tactile materials, visual presentation or clues, movement or action, or hands-on activities.

Teachers can facilitate intellectual disability students with foundational literacy skills by adopting technology-related instruction methods (Wilson & Hunter, 2010). In conclusion, technology related instruction methods and interactive activities involving more than one sensory organ are efficient ways of enhancing intellectual disability students' foundational literacy skills.

Need for the study

The necessity for this study stems from limited access for students with intellectual disabilities to acquire useful literacy skills due to ineffective or lack of literacy instruction (Coyne et al., 2010). The main concern of this research is to respond to the above gap by examining the effect of a technology-based instructional strategy on developing basic literacy skills among students with intellectual disabilities (Sari et al., 2018). Use of technology enables learning experiences in the classroom to be interactive and more individualized and engaging, at the same time addressing the needs of students with intellectual disabilities. The purpose of the current study is to fill the gap of effective instruction of literacy to intellectually disabled students by studying the effectiveness of technology-based instruction.

To enhance basic literacy skills of intellectually disabled students, technology-based teaching strategies should be considered. Research has suggested that technology-based universal design for learning (UDL) strategies might prove useful for young children with severe intellectual disabilities (Coyne et al., 2010) and that accessible portable technology like the iPad2 might enhance literacy skills among elementary students with severe disabilities (Spooner et al., 2015). Additionally, assistive technology has been recognized as a crucial component of literacy education for students who have significant disabilities and enables teachers to move their knowledge and practices of teaching literacy with students with and without disabilities to students who have significant intellectual disabilities (Erickson et al., 2010).

Additionally, there has been suggestion of explicit or carefully constructed instruction in early literacy as significant for all students, including students with learning disabilities to reading (Haager & Vaughn, 2013), and certain students may need specific focused direct instruction and extra practice in order to master these early skills. Further, the application of instructional technology has been identified to be among the energizers in a math class to introduce new concepts to study, as well as providing children with ID with choices regarding what they could wear depending on the initial instruction, (Adiat et al., 2013). Additionally, appropriate curricula, instructional procedures, and materials have also been heuristics recommended to assist in developing literacy skills among students with ID (Sari et al. 2018).

Lastly, professional workshops offering services to disabled children have also been proposed to dictate the importance of adopting proper instructional strategies in developing reading competence among students with disabilities (Jacob & Pillay, 2022). During clinical experience, incorporating technology-based instruction strategies - for instance UDL and assistive technology approaches - has been reported to achieve good results when supporting students with ID in enhancing their emerging literacy skills. Using targeted or carefully designed instruction with technology has given students with ID the correct leverage to build crucial literacy skills.

Objective of the study

- To find out the effectiveness of OR Code embedded technology oriented instructional strategy in improving reading comprehension of students with Intellectual disabilities.

Hypothesis of the study

- There exists a significant improvement in the reading comprehension skills of students with Intellectual disabilities before and after implementing OR Code embedded technology-oriented instructional strategy.

Methodology

The case study approach was used in this research to investigate the intricate character of the topic at hand, utilizing the qualitative research analysis.

With the case study approach, researchers could make independent judgments, and this enabled them to meticulously note activity they observed during the data collection process. Through this approach, the researchers' hope to acquire an extensive understanding of the types of activities and challenges that the population being studied encounter. The application of the case study technique enabled an in-depth probe as well as an expansive comprehension of the issues at the current time. This approach provided the researchers with an ability to collect an extensive variety of data. SAMPL

This study used the case study approach to examine the complex nature of the research topic through qualitative analysis of research. The researchers were able to make their own judgments with the use of case study procedures and, therefore, had the capability of precisely documenting what they witnessed as they gathered data. The researchers were keen on their exploratory case study research; this allowed them to gather detailed information regarding the range of experiences and challenges encountered by the case study population; and a case study approach allowed for a greater depth study of the issues within the current case study. The case study approach also allowed the researchers to gather a broad range of data.

Procedure

Within the scope of this case study research, the researchers of the study created ten units of complete framework. The above framework was employed to monitor and examine the activity of the population of case study research. The researchers adopted the method of the case study research step by step and were asked to record any activities that would be included in the case study.

The methodical approach of case study research permitted a deeper probing of the behavior of the case study population and to create an organized framework for note-taking and analysis of observed activities. The entire ten-unit framework follows below: 1.விரும்பி விளையாடலாம் (Feel free to play), 2.விரலோடு விளையாடு (Play with finger), 3.எதுவும் கடினமில்லை (Nothing is Difficult), 4.நாங்கள் நண்பர்கள்(We are friends)., 5.கண்டுபிடி கண்டுபிடி(Find Find), 6.சின்னுவின் பயணம்(Chinnu's journey), 7.எங்கள் தனித்திறமை (Our uniqueness), 8.இறகு யாருடையது(Whose father is it)?, 9.எங்கே போகலாம்? (Where can we go), 10.கேட்போம்! கேட்போம்! (Let's listen! Let's ask!).

Research Design

This research was constructed in two phases. The pre-test observation and the post-test observation. The pre-test was administered before initiating the technology-oriented instructional approach to evaluate the initial reading comprehension skills capability of the intellectual disability students. The data were to create a baseline of the students' reading comprehension skills.

Once the QR Code Embedded Technology-Oriented Instructional Strategy was implemented, investigators gathered the post-test data for the investigation.

The paragraph explains the pre-test and post-test observation, pointing out the quantity of ten units for each observation, individually or collectively. The general discussion section captures all the investigators' observations.

Case Study I

Pre-Test Observation

During P1's pre-test observation, who is an intellectually disabled student, a stark contrast in comprehending book materials using traditional methods was observed.

Despite the continuous efforts of the teacher to get in touch with and communicate with P1, the student lacked positive responsiveness. When instructed to describe a drawing from the print copy of the book, P1 categorically refused with a strong "No, I don't like and I don't want." The teacher, tried motivating good behavior by proposing to P1 that she could learn new words through filling in a specified number. P1 responded by staying put, being clearly visibly uncomfortable and not responding. The teacher, feeling the necessity of slowing down and using other approaches, proceeded with the discussion, stating, "P1, we can do this simultaneously. Rent's explore for somewhat that will make learning fun for you. What zones are you most interested in? We can make our lessons in response to it." Even with these efforts, P1 remained resistant, quoting the difficulty in working with the individual learning needs of students with intellectual disabilities. This case highlights the need to implement customized and creative teaching strategies in order to fill the understanding gap and to create a good learning atmosphere for students who are intellectually challenged.

Post-Test Observation

After applying the QR Code Embedded Technology-Oriented Instructional Strategy to P1, the revolutionary effect on the learning and engagement of the student was observed.

P1 not only showed more interest in investigating new units but also brought attention from the teacher, saying, "Sir, sir, see how the cow is calling me." Adopting the technology, the teacher replied, "Yes, my dear, the cow 'calls' us like that when she's hungry." The QR-based strategy not only stimulated curiosity but also led P1 to want to recreate the drawing, asking, "Sir, I want to draw this picture, and will my dog also 'call' me?" Encouraged, "Yes, if you take all my steps, your dog will definitely 'call' you too." Interestingly, the QR Code strategy allowed for behavioral transformations in the student, creating a cheerful learning experience. P1 not only adopted the tool but also tried to scan codes on their own. Aside from the direct effect, the QR Code strategy revealed an even greater realization of picture relationships and history, creating connections between pictures and relationships within society. This study argues that QR-based strategies become great tools, introducing a better and more contemporary method of learning and teaching. In addition, it represents a departure from standard practices and paves the way for an innovative, arts-centered classroom that is sensitive to the particular requirements of students with intellectual disabilities. The conversation progressed when the teacher stated, "P1, let's learn this new unit together using the QR Code," as the teacher continued to work with P1 through the QR Code activities. Can you locate the code by yourself?" P1 replied with excitement, "Yes, sir! I can do it!" With the encouragement of the progress, the teacher proceeded, "Excellent, P1! Now, let's see what the code tells us about the animals in the photograph." P1, enthusiastically nodding towards the screen, commented, "Look, sir! The animals are friends, just like we are!" The teacher took the opportunity to enhance meaning, stating, "Absolutely, P1! Our QR adventure not only teaches us about photographs but also about the connections between various things. What else do you think we can discover today?" P1, looking contemplative, answered, "Perhaps we can learn about how plants grow, sir!" The teacher praised the observation, "Excellent, P1! Let's visit that later in our next QR adventure." This exchange is indicative of the interactive engagement brought about by QR Code approaches that enable interactive and individualized learning for students with intellectual disabilities.

A.Case Study II

Pre-Test Observation

In exploring the pre-test observations of P2, an intellectually disabled student, a significant gap in understanding book material through traditional methods presented itself.

Despite the genuine efforts of teachers to communicate and teach, constructive responses from P2 continued to elude them. In a bid to make learning a combination of learning through a drawing activity from the book's print version, the teacher called for collaboration, uttering, "P2, let's do this drawing together. Can you sketch it out for me?" P2 replied with a forceful refusal with consistent "no no no, I not want." The teacher, recognizing the call for a positive behavioral intervention, went on, "P2, I know you can do this. Let's try and celebrate your achievement later." The student's interest, however, eluded him. To attempt a different strategy, the teacher said, "P2, what if we color this picture and make it bright and beautiful? It can be enjoyable, and we'll discover things as well." These attempts notwithstanding, P2 remained resistant to participation in the school task. The instructor continued trying to make the learning process more engaging, "P2, let's visit the box-matching activity together. If you match them, we can discover new, interesting ideas. What are your thoughts? P2's reaction was passive, as the student sat back rather than actively engaging. This case shows how difficult it is to meet the needs of students with intellectual disabilities. It also shows how important it is to use creative and individualized teaching methods to get students interested and involved in the education process.

Post-Test Observation

Within the implementation of the QR Code Embedded Technology-Oriented Instructional Strategy for P2, an obvious improvement in the student's interest and responsiveness to learning was evident.

P2 not only showed increased interest in discovering new units but also showed fascination, exclaiming, "Sir, sir, the picture is moving and making sound!" By maximizing the use of the QR code's interactive potential, the teacher showed, "Yes, my dear, the picture is indeed moving." Building on this increased interest, the teacher asked, "Can you tell me the name of this vehicle?" P2 replied quite confidently, "This is a bus." The QR-based method not only allowed understanding but also directed the attention of P2 towards making a new drawing. Happily, P2 revealed, "Sir, I played with that car at home." Not wanting to let go of the chance, the teacher suggested, "Yes, if you finish today's assignment, we can get a new car for you tomorrow." QR Code strategy not only generated interest but also created positive behavior modification in P2, creating a long-lasting sense of joy in operating the QR app. To everybody's surprise, the pupil even dared to try scanning codes on his own. In later interactions, the teacher continued to engage P2, saying, "Let's discover another QR code together. Can you locate the code independently this time?" P2, hungry to take part, replied, "Yes, sir! I'll do it!" Spurred on by the enthusiasm of the student, the teacher went on to say, "Good work, P2! Now, let's crack the code and discover more about the world around us." P2, mesmerized by the revelations, said, "Look, sir! This code depicts various kinds of animals. I like the lion; it's so powerful!" Recognizing the interest, the teacher replied, "Yes indeed, P2! Animals are amazing. What other animals would you like to learn about?" P2, now vivified by curiosity, recounted, "I'd like to learn about birds and how they fly, sir." The teacher applauded the selection, saying, "Excellent, P2! Our QR adventure will take us to discover the miracles of the world of birds next. Keep going with the curiosity!" This sequence of conversations illustrates the interactive and dynamic nature of QR Code approaches, demonstrating their effectiveness in building engagement, curiosity, and learning experiences tailored to students with intellectual disabilities in reading comprehension.

B. Case Study III

Pre-Test Observation

Within the analysis of pre-test observations with P3, an intellectually disabled student, a significant lack of comprehension of book material through traditional means was revealed.

Despite the commitment of teachers to provoke discussion and offer direction, constructive engagement from P3 was elusive.

The instructor encouraged collaboration by saying, "P3, let's discover this unit together," as she struggled to engage students with a drawing activity based on the printed book. What is the animal in this picture's name?" P3 uttered a resolute refusal, declaring, "This is animal.," the teacher, acknowledging the value of promoting a positive attitude, persisted, "P3, I think you can do it. Let's practice this together, and we can rejoice over your successes. Find the right spelling of 'cow' from your book." Unsuccessful in these attempts, P3's enthusiasm continued to prove elusive.

Testing another approach, the teacher suggested, "P3, think about how exciting and colorful our drawing will be when we add many colors. Let's have fun with it together." Sadly, P3 continued to defy active engagement in the school assignment. The teacher continued on, trying to make learning more interesting, "P3, let's try a color-matching exercise. If you match them up, we can find great new ideas. What do you think?" Unfortunately, P3's reaction was still passive, with the student choosing to sit without engagement. In response to the challenge, the teacher had continued dialogue, saying, "P3, your opinions are important. Tell me what you like to learn about. Find a way to incorporate those interests into our curriculum." But P3 continued to be tight-lipped. Unfazed, the instructor continued, "P3, I would like to make our learning process a pleasurable experience for you. What learning activities or subjects interest you?" The student's interest continued to elude, despite persistent efforts to customize the learning process to suit P3's interests, highlighting the intricate task of addressing the individual needs of learners with intellectual disabilities and the need for flexible and creative teaching approaches. Post-Test Observation The application of the QR Code Embedded Technology-Oriented Instructional Strategy was transfigurative for P3, as reflected in increased interest and learning receptivity.

P3 exclaimed joyfully, "Sir, sir, the girls are playing with her pet; I want to join!" The teacher responded, "Indeed, my dear, the girls are playing." Capitalizing on this curiosity, the teacher inquired, "Are you aware of the pet's name?" P3 replied confidently, "This is a cat." The QR-based method not only helped comprehension but also guided P3's focus towards making a new drawing. Excitedly, P3 said, "Sir, I have a cat at home, and I enjoy playing with her." Taking advantage of the moment, the teacher encouraged, "Absolutely, if you complete today’s unit, we can bring a cat for you tomorrow, and you can play with her once more." The QR Code strategy did not only generate interest but also created positive behavioral changes in P3, generating a lasting sense of joy in utilizing the QR app.

Remarkably, the student even ventured to attempt scanning codes independently.

In the follow-up interactions, the teacher again interacted with P3, stating, "Let us scan another QR code together. Can you scan the code on your own this time?" P3, with enthusiasm to be involved, replied, "Yes, sir! I'll scan it!" Empowered by the initiative of the student, the teacher went further, saying, "Great work, P3! Now, let us solve the mystery of this code and learn more about the world around us." P3, fascinated by the unfolding knowledge, stated, "Look, sir! This code displays various types of plants. I like the flowers; they are so pretty!" Being attentive to the interest, the teacher replied, "Absolutely, P3! Nature is lovely. What other plants are you interested in?" P3, now filled with interest, stated, "I'd like to learn about trees and how they grow, sir." The teacher praised the selection, stating, "Fantastic, P3! Our QR adventure will take us to learn about the marvels of the plant kingdom next. Continue with the interest!" This series of exchanges illustrates the interactive and dynamic nature of QR Code strategies, demonstrating their effectiveness in building engagement, curiosity, and individualized learning experiences among students with intellectual disabilities. C. Case Study IV Pre-Test Observation In the examination of pre-test observations of P4, an intellectually disabled student in Alagappa University, the striking difference in understanding book content in a conventional manner emerged. Beyond the diligence of the teachers in communicating and teaching, the reactions of P4 were lackluster. In an effort to involve the student in a drawing activity from the book's print version, the teacher invited participation by stating, "P4, let's draw something together. Can you trace this drawing?" In a distraction from the academic task, P4 answered with a request for play, stating, "I want to play, I want ball." the teacher, acknowledging the importance of flexibility, replied, "Yes, we can play, but let's do some new words also. How about giving me a number and we can find a new word together?" Despite these efforts, P4 seemed disengaged, choosing to sit in a chair and fiddle with a toy instead.

The teacher persisted, attempting to bridge the distance by using a caring tone, "P4, I understand that you want to play. Learning can also be enjoyable. What if we add some fun to education? You can choose a favorite activity, and we'll explore ways to incorporate learning into it. Unfortunately, the shift in P4's focus towards learning activities was not achieved smoothly.

This scenario emphasizes the intricate challenge of engaging with students with intellectual disabilities, accentuated by the necessity for personalized, flexible teaching methods that integrate play and education to promote an inclusive and effective learning atmosphere

Post-Test Observation

As the QR Code Embedded Technology-Oriented Instructional Strategy progressed for P4, a significant change in the student's motivation and interest in learning became evident.

P4 not just showed an increased enthusiasm to discover new units but also said, "Sir, sir, the number is calling me too." Grabbing the teachable moment, the teacher explained, "Yes, my dear, the number is not calling you. It is exposing its own spelling." The strategy based on QR not just strengthened P4's knowledge but also ignited a creative urge, with the pupil looking forward to drawing a new picture. P4 subsequently asked, "Sir, am I allowed to color this picture? Would my home dog accept this color?" The teacher replied affirmatively, remarking, "Yes, if you finish all the units today, tomorrow you can color the cat to look like your home pet." The QR-based devices played a crucial role in invoking behavior changes in P4, allowing them to have a sustained feeling of enjoyment and curiosity in utilizing the QR app. Interestingly, the student even made an effort to scan codes on her own. Through these QR strategies, P4 not only understood the relationship between images and their history but also was able to identify their relevance at a larger social level. Continuing the conversation, the instructor asked, "P4, let's try another QR code and see what great information it carries. Can you locate the code on your own?" P4 took up the challenge readily, exclaiming, "Yes, sir! I'll do it!" P4's active engagement was met with encouragement by the instructor, who proceeded, "Great, P4! Let's now discover the history of the code and find out what new concepts it generates." P4, with a look of expectation, revealed, "Look, sir! This code is about nature, and it displays the way trees grow. It's wonderful!" Recognizing the observation, the instructor replied, "You're right on the money, P4! Nature is really amazing, and we can learn much from it. What other wonders of nature interest you?" P4, now more assured, revealed, "I want to learn about other animals and how they live, sir." The instructor confirmed, "Excellent option, P4! Our QR adventure will take us through the world of the wonders of the animal kingdom next. Keep up the spirit!" This exchange depicts the energetic and engaging learning process supported by QR Code approaches, affirming their effectiveness in developing interest and comprehension among students with intellectual disabilities while moving away from classic approaches towards a newer and innovative classroom practice.

Overall Discussion

Implementation of Technology-Oriented Instructional Strategy

The application of a QR Code Integrated Technology-Oriented foundation numeracy and literacy instructions based on the textbook on Numeracy and Literacy for students with Intellectual Disability published by Tamilnadu Government Textbook Corporation. Instructional strategy was using Augmentative Reality QR codes incorporated in units' textbook, the implementation of this technology was aimed at developing interesting and interactive learning, while embracing students with intellectual disabilities' needs. This technology-based implementation was seeking to use multimedia to facilitate understanding and possibly follow different learning styles with the intervention group. General perspective of Impact Pre-test and post-test assessment of P1, P2, P3, and P4 students after the application of the QR Code Embedded Technology-Oriented Instructional Strategy showed a revolutionary effect on their learning experience.

There was a wide gap in the understanding of traditional instructional approaches for P1, P2, P3, and P4 students with intellectual disabilities prior to the intervention.

But when the QR-based approach was introduced, there was an impressive change seen in their interest and willingness to learn.

P1 showed increased interest, taking an active part in drawing activities and showing willingness to learn new vocabulary.

P2, fascinated by the dynamic nature of QR-coded images, showed increased curiosity and interest, which resulted in improved participation in study activities. P3, enthralled by the interactive aspect of the strategy, not only enhanced in identifying and labeling objects but also revealed a keen interest in the topic. P4 demonstrated significant improvement, with the QR Code strategy promoting good behavioral changes and continued enthusiasm for learning.

These children, who at first showed hesitance and lack of interest, became engaged in learning, with P4 even trying to scan codes on their own.

The QR-based teaching approach met the cognitive learning requirements of students with intellectual disabilities and generated renewed interest in subjects, fostering a positive and inclusive educational atmosphere. The results from the post-test demonstrated significant improvements in comprehension, involvement, and behavioral responses, affirming that QR-based approaches serve as effective resources for improving the learning-teaching experience. The positive results noted in P1, P2, P3, and P4 highlight the potential of QR Code technology to overcome the limitations of conventional teaching approaches, fostering a more contemporary, interactive, and tailored educational experience for students with intellectual disabilities. This study supports the continuous investigation and incorporation of modern teaching techniques, like QR Code technology, to develop inclusive and effective learning environments that cater to the diverse requirements of students with intellectual disabilities.

Summary This article examines QR codes embedded technology-oriented teaching strategy for enhancing foundational literacy skills in students with intellectual disabilities.

The technology-driven instructional approach included using a QR code based material – a Numeracy and Literacy textbook for students with Intellectual Disability - published by Tamilnadu Government Textbook Corporation. The difference lay in the use of visual content in the form of QR codes. The units that were used included "Feel free to play", "Play with finger", and several other units. The pre-test tested basic literacy skills that would be employed in the application of the integrated technology-based QR codes to report on students' learning experience with diverse learning styles. Post-test outcomes revealed that the QR code embedded technology-based instructional strategy significantly affects enhancing their foundational literacy skills of intellectually disabled students. The technology-based strategies bear implications/positive effects on instruction of intellectually disabled students. Suggestions

The research can explore possibilities of boosting the instructional strategy utilizing qualitative information in fine-tuning the QR code embedded technology-based instructional strategy.

Recognizing certain factors that contribute towards improving understanding would offer a doorway to incorporate the information in the future. You might think about a follow-up study that would examine the sustainability of the QR code technology-based instructional approach in relation to reading understanding. Moreover, future studies would be able to incorporate a comparison with the more conventional instructional approach employed in the present study, giving a more comprehensive picture of the technology approach in reading comprehension. Additionally, upcoming research might investigate how media components can accommodate different learning styles in educational environments. Understanding learners' preferences and responses can aid in creating more inclusive teaching methodsIf successful, consider creating training for teachers to more effectively enable the QR code integrated technology-infused instructional strategies.

Teacher support and knowledge are essential elements for effective implementation in more traditional educational settings. Lastly, another suggested area of inquiry is testing the generalizability of results to other educational settings and diverse student populations. Overall, the possible results could together improve the scalability and adaptability of the technology-based method. To summarize, the article offers valuable perspectives on how a technology-focused teaching approach can improve reading comprehension skills in students with intellectual disabilities. The suggestions aim to enhance and broaden the study's impact, facilitating continual advancements in inclusive education methods

Conclusion

The instructional approach with technology using QR code supported resources for developing foundational literacy skill showed a positive effect for meeting the instructional needs of students with intellectual disabilities. The research, in which a unique solution with QR code supported technology-based instructional approach in specially designed instructional text book was introduced, was trying to make foundational literacy skill better for students with intellectual disabilities. The article suggests potential areas for future research, including creation of a more sophisticated instructional strategy, effect over time and comparison with conventional approach. In addition, the research also illustrates its impact in special education in terms of learning style insight covered through multimedia, teacher training for application and generalization of the findings to other settings. In general, the study strives to close the literacy gap for students with intellectual disabilities by the application of technology to enable students to acquire basic literacy skills. The results of the current study give educators, policy makers and researchers insightful findings to further develop inclusive classrooms for all students to succeed in learning basic literacy skills.

Conflict Interest

The author(s) declare no competing interests.

Funding

This research was completed with financial support from the Theme-Based RUSA 2.0 Project fund provided by Alagappa University

References

1. Adiat, T., Ahmad, A., & Ghazali, M. (2013). Attitude of parents-teachers towards the use of instructional technology in teaching numeracy to children with mild intellectual disability: a case of penang Malaysia. *Iosr Journal of Humanities and Social Science*, 7(2), 43-47. https://doi.org/10.9790/0837-0724347
2. Coyne, P., Pisha, B., Dalton, B., Zeph, L., & Smith, N. (2010). Literacy by design. Remedial and Special Education, 33(3), 162-172. https://doi.org/10.1177/0741932510381651
3. Erickson, K., Hatch, P., & Clendon, S. (2010). Literacy, assistive technology, and students with significant disabilities. Focus on Exceptional Children, 42(5). https://doi.org/10.17161/foec.v42i5.6904
4. Haager, D. and Vaughn, S. (2013). The common core state standards and reading: interpretations and implications for elementary students with learning disabilities. Learning Disabilities Research and Practice, 28(1), 5-16. https://doi.org/10.1111/ldrp.12000
5. Jacob, U. and Pillay, J. (2022). Instructional strategies that foster reading skills of learners with intellectual disability: a scoping review. Cypriot Journal of Educational Sciences, 17(7), 2222-2234. https://doi.org/10.18844/cjes.v17i7.7589
6. Sari, H., Gökdağ, H., & Kizilkaya, A. (2018). Evaluation of special education teachers' opinions about literacy textbooks, teaching individuals with intellectual disabilities. *Journal of Modern Science*, 38(3), 53-72. https://doi.org/10.13166/jms/95049
7. Sari, M., Baek, J. H., & Simmons, D. C. (2018). Contextualized literacy instruction for students with intellectual disabilities: A review of the literature. *Journal of Special Education*, 52(4), 306-323.

8. Sari, S. W., Sunaryo, S., & Mugiono, M. (2018). The effect of service quality on customer retention through commitment and satisfaction as mediation variables in java eating houses. *Jurnal Aplikasi Manajemen*, 16(4), 593-604.
9. Spooner, F., Kemp-Inman, A., Ahlgrim-Delzell, L., Wood, L., & Davis, L. (2015). Generalization of literacy skills through portable technology for students with severe disabilities. Research and Practice for Persons with Severe Disabilities, 40(1), 52-70. https://doi.org/10.1177/1540796915586190
10. Wilson, D. M., & Hunter, A. G. (2010). Motivating students to read and write: Strategies for success. Allyn & Bacon.

About the Editors

Dr. M. Karuppasamy M.A., M.Sc., M.Phil., M.Ed., M.Ed. (Special Education), Ph.D., is the Head of the Department of Special Education at the Government Rehabilitation Institute for Intellectual Disabilities (GRIID), Chandigarh. He is an academician and researcher with over 20 years of experience in the field of Special Education, encompassing teaching, research, training, and academic administration. His expertise includes inclusive education, intellectual and developmental disabilities, and teacher education. Dr. Karuppasamy has guided several M.Ed. M.Phil and co guide for Ph.D. scholars and has published numerous research papers, book chapters, and academic articles in reputed journals. He has served on various academic and professional committees, contributing to curriculum design, quality assurance, and policy formulation in the field of special and inclusive education. As Head of the Department, he continues to lead academic programs, research initiatives, and capacity-building efforts aimed at enhancing educational practices and promoting inclusive learning environments for persons with disabilities.

Prof. J. Sujathamalini Professor and Head, Department of Special Education and Rehabilitation Science, and Dean, Faculty of Education, Alagappa University, Karaikudi, is an eminent academician with vast experience in Special and Inclusive Education. She holds an M.Ed. Special Education and Ph.D. in Education and has over two decades of experience in teaching, research, and academic administration. She has successfully guided 21. Ph.D and 32 M.Phil. scholars in the fields of Education, Special Education, and Rehabilitation Science. Dr. Sujathamalini serves on various academic and administrative committees at the university and national level, contributing to curriculum development, policy formulation, and quality assurance in higher education.Her scholarly contributions, academic leadership, and commitment to inclusive educational practices have been instrumental in shaping this publication, which aspires to promote innovative research and professional excellence in Special Education.

ISBN
9 789361 637322

DOI : doi.org/10.34293/shanlax.9789361637322

SHANLAX PUBLICATIONS
www.shanlaxpublications.com
publisher@shanlaxpublications.com